

Nursing Care In The Prevention And Management Of Catheter-Associated Urinary Tract Infections (Cautis): An Evidence-Based Review

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Abstract

Catheter-associated urinary tract infections (CAUTIs) represent one of the most common and preventable healthcare-associated infections (HAIs) globally, posing a significant threat to patient safety and creating a substantial economic burden on healthcare systems. Nurses, positioned at the center of patient care, play the most critical role across the entire continuum of urinary catheterization. This review synthesizes current, evidence-based literature on nursing-led interventions designed to prevent and manage CAUTIs. The analysis is structured around four foundational pillars of nursing practice: ensuring the appropriate use of indwelling catheters by avoiding unnecessary placement and championing alternatives; adhering to strict aseptic technique during insertion; providing diligent, evidence-based daily maintenance of the catheter and drainage system; and facilitating the timely removal of catheters through vigilant daily assessment and nurse-driven protocols. Furthermore, this review examines the nurse's role in surveillance, including the early recognition of CAUTI signs and symptoms, proper specimen collection, and effective communication within the interprofessional team. System-level supports, such as prevention bundles, ongoing education, performance feedback, and patient engagement, are discussed as essential components for creating a sustainable culture of safety. By empowering nurses with knowledge, autonomy, and evidence-based protocols, healthcare organizations can significantly reduce CAUTI rates, decrease patient morbidity and mortality, and improve the overall quality and safety of care.

1.0 Introduction: The Persistent Challenge of CAUTIs

1.1 The Epidemiology and Burden of CAUTIs

Catheter-associated urinary tract infections (CAUTIs) remain a persistent and formidable challenge in modern healthcare, representing one of the most prevalent healthcare-associated infections (HAIs) worldwide . Globally, CAUTIs comprise up to 35% of all HAIs, with reported frequencies of 12.9% in the United States, 19.6% in Europe, and 24% in developing nations . This high prevalence is directly linked to the widespread use of indwelling urinary catheters (IUCs); an estimated 12% to 25% of all hospitalized patients will have an IUC placed at some point during their stay, creating a vast population at risk . The sheer scale of this issue in the United States is staggering, with estimates suggesting between 449,334 and 560,000 CAUTI events occur annually .

The clinical consequences for patients are severe. The risk of acquiring bacteriuria increases by 3% to 7% for each day an IUC remains in place, making duration of catheterization the single most important risk factor . These infections can lead to a cascade of complications, including cystitis, pyelonephritis, gram-negative bacteremia, and sepsis, which can be life-threatening, particularly in vulnerable populations . Annually, more than 13,000 deaths in the U.S. are associated with urinary tract infections, a significant portion of which are catheter-associated . Furthermore, CAUTIs are a leading cause of secondary hospital-acquired bloodstream infections, contributing to increased patient morbidity and mortality .

Beyond the profound impact on patient health, the economic burden of CAUTIs is immense. An individual CAUTI event is associated with an increased hospital length of stay of two to four days, which not only occupies valuable bed space but also exposes the patient to further risks of hospital-acquired conditions . The attributable costs are substantial and vary widely based on patient acuity and the presence of complications. Estimates range from a conservative \$758 to \$1,768 per case for non-ICU patients to well over \$10,000 for pediatric or ICU patients . Some analyses place the upper cost limit for a single complicated case as high as \$22,568 . Cumulatively, the annual cost to the U.S. healthcare system is estimated to be between \$340 million and \$450 million . This financial strain is exacerbated by policies from payers like the Centers for Medicare & Medicaid Services (CMS), which no longer reimburse hospitals for the costs associated with treating these preventable infections, placing the financial onus directly on the healthcare facility .

1.2 Defining CAUTI: A Brief Overview of Standardized Surveillance Definitions

To accurately track, manage, and prevent CAUTIs, a standardized surveillance definition is essential. Such a definition allows for consistent data collection across institutions, facilitates meaningful research, and enables the differentiation between a true, symptomatic infection requiring treatment and asymptomatic bacteriuria (ASB), which often does not . The U.S. Centers for Disease Control and Prevention's (CDC) National Healthcare Safety Network (NHSN) provides the most widely used and accepted surveillance definitions for HAIs, including CAUTI .

According to the NHSN, a CAUTI is defined as a urinary tract infection that occurs in a patient who had an indwelling urinary catheter in place for more than two consecutive days in an inpatient location on the date of the event or the day before . This temporal link is critical. The surveillance criteria for a Symptomatic Urinary Tract Infection (SUTI) are multifaceted and require the simultaneous presence of clinical symptoms and microbiological evidence, all occurring within a defined "infection window period" . This rigorous approach helps to prevent the misclassification of catheter-associated asymptomatic bacteriuria as a true infection. The evolution of these definitions, such as the 2015 exclusion of *Candida* species from the criteria, demonstrates a continuous effort to improve surveillance accuracy. This change was based on evidence that candiduria in catheterized patients more often represents colonization than a true infection, and its exclusion was shown to decrease reported CAUTI rates by as much as 46% in some institutions, highlighting how definitional precision directly impacts reported hospital performance metrics .

The core components for diagnosing a symptomatic CAUTI are summarized in Table 1.

Table 1: CDC/NHSN Surveillance Criteria for Symptomatic CAUTI (SUTI)

Criteria Component	Requirement
1. Device Criteria	An indwelling urinary catheter (IUC) must have been in place for more than two consecutive calendar days on the date of event (with day of placement being Day 1). The IUC must have been in place on the date of event or the day before .
2. Symptomatic Criteria	The patient must have at least one of the following signs or symptoms with no other recognized cause: • Fever ($>38.0^{\circ}\text{C}$) • Suprapubic tenderness • Costovertebral angle pain or tenderness Note: Symptoms such as urinary urgency, frequency, or dysuria cannot be used as criteria in a patient with an indwelling catheter, as the device itself can cause these sensations.
3. Microbiological Criteria	A positive urine culture with no more than two species of organisms identified, at least one of which is a bacterium of $\geq 10^5$ colony-forming units (CFU)/mL.

1.3 The Pathophysiology of Catheter-Associated Infection

The pathogenesis of CAUTI is intrinsically linked to the presence of the indwelling catheter, a foreign body that fundamentally disrupts the urinary tract's natural, sterile environment and impairs innate host defense mechanisms. The catheter provides a direct conduit for microorganisms to bypass these defenses and access the bladder. Microbial entry occurs via two primary pathways. The first is the **extraluminal route**, where microorganisms from the patient's perineal or rectal flora colonize the external surface of the catheter upon insertion and ascend into the bladder along the catheter-urethral interface. The second is the **intraluminal route**, which involves contamination of the catheter's internal lumen, typically occurring from a contaminated drainage bag or a break in the closed drainage system at the catheter-tubing junction .

Once microorganisms gain access to the catheter surface, the central pathogenic event begins: the formation of a **biofilm** . This process is almost inevitable on any foreign body connecting a sterile, hydrated site to the external world. Biofilm development proceeds in a series of predictable steps. First, the inert catheter material is coated with a "conditioning film" composed of host-derived urinary components like proteins and electrolytes. This film neutralizes any anti-adhesive properties of the catheter material and creates a receptive surface for microbial attachment. Free-swimming (planktonic) bacteria then adhere to this conditioned surface. Following attachment, these initial colonizers multiply and begin to secrete a protective, slimy matrix of extracellular polymeric substances (EPS), which is composed of polysaccharides, proteins, lipids, and DNA . This matrix encases the growing microbial community, allowing it to mature into a complex, three-dimensional structure. This structure is not a simple layer of bacteria but a sophisticated community with fluid channels that permit the exchange of nutrients and waste .

The formation of a mature biofilm represents a critical turning point in the infection process, creating a state that is highly resistant to both the host's immune response and antimicrobial therapy. Bacteria residing within a biofilm can be up to 1,000 times more resistant to antibiotics than their planktonic counterparts . This profound resistance is not primarily due to the antibiotic's inability to penetrate the matrix; rather, it stems from the altered metabolic state of the bacteria within the biofilm, which grow much more slowly and are thus less susceptible to antibiotics that target cellular replication. This understanding frames the biofilm as a near "point of no return," where eradication of the infection becomes nearly impossible without the physical removal of the catheter itself. This pathophysiological reality powerfully underscores that the

clinical focus must be on preventing biofilm formation in the first place, primarily by minimizing the duration of catheterization. The most common uropathogens implicated in CAUTI, including gram-negative bacilli like *Escherichia coli*, *Klebsiella* species, and *Pseudomonas aeruginosa*, are all adept at forming these resilient biofilms .

1.4 The Centrality of the Nurse's Role

In the multifaceted effort to combat CAUTIs, the professional nurse stands as the central and most critical agent of prevention. From the initial consideration of catheter placement to the moment of its removal, nurses are uniquely positioned to influence outcomes at every stage of the catheter's lifecycle. They are the gatekeepers who assess the appropriateness of catheter orders, the skilled clinicians who perform aseptic insertion, the vigilant guardians who provide daily maintenance, and the patient advocates who champion timely removal . The prevention of CAUTI is not a single event but a continuous process of assessment, intervention, and communication, all of which are core functions of professional nursing. This review will explore the evidence-based nursing practices that form the pillars of CAUTI prevention and management, positioning the nurse as the primary guardian of patient safety in this persistent challenge.

2.0 Foundational Pillars of CAUTI Prevention: The Nurse's Proactive Role

Effective CAUTI prevention is not a passive process but an active, moment-to-moment commitment driven by nursing vigilance and critical thinking. It rests on four foundational pillars that align with the lifecycle of the urinary catheter: avoiding unnecessary catheterization, ensuring aseptic insertion, providing diligent daily maintenance, and securing timely removal. Each pillar requires deliberate nursing action and advocacy, transforming a simple checklist of tasks into a dynamic professional practice.

2.1 The First Line of Defense: Avoiding Unnecessary Catheterization

2.1.1 Nurse-Led Assessment of Appropriate Indications

The single most effective strategy to prevent a CAUTI is to avoid inserting an indwelling urinary catheter in the first place . Nurses, as the clinicians with the most consistent and direct patient contact, are the primary gatekeepers in this crucial decision-making process . A core professional responsibility is to critically evaluate the necessity of every catheter, whether ordered preemptively or in response to a clinical change. This requires a thorough understanding of the evidence-based criteria for appropriate catheter use, as outlined by organizations such as the CDC.

These guidelines provide a clear framework for clinical judgment. As detailed in Table 2, appropriate indications are limited to specific clinical scenarios where the benefits of an IUC are deemed to outweigh the significant risks . Conversely, the use of an IUC for reasons of convenience, such as managing incontinence as a substitute for nursing care or obtaining a urine specimen when a patient can void, is explicitly inappropriate and must be challenged . The nurse's role extends beyond mere implementation of orders; it involves actively questioning indications that do not align with best-practice guidelines and advocating for the patient's safety by recommending less invasive alternatives .

Table 2: Appropriate vs. Inappropriate Indications for Indwelling Catheterization

Appropriate Indications	Inappropriate Indications
• Acute urinary retention or bladder outlet obstruction .	• As a substitute for nursing care for a patient with incontinence .
• Need for accurate, often hourly, measurement of urinary output in critically ill patients .	• As a means of obtaining a urine culture when a patient can void voluntarily .
• Perioperative use for selected surgical procedures (e.g., urologic surgery, prolonged surgery,	• For prolonged postoperative use without a specific indication .

Appropriate Indications	Inappropriate Indications
anticipated large-volume infusions) .	
• To assist in healing of severe, open sacral or perineal wounds in an incontinent patient .	• Routinely for patients in intensive care units without a clear indication for strict output monitoring .
• Patient requires prolonged immobilization (e.g., unstable spine, multiple traumatic injuries) .	• Patient or family request for convenience .
• To improve comfort for end-of-life care .	

2.1.2 Championing Alternatives to Indwelling Catheters

When a patient requires urinary management but does not meet the strict criteria for an IUC, nurses must champion the use of suitable alternatives. A comprehensive, nurse-led incontinence and retention management plan can significantly reduce reliance on indwelling devices. Key alternatives include:

- **External Catheters:** For male patients, external "condom" catheters are a well-established alternative that significantly lowers the risk of infection and is often preferred by patients . Proper sizing and skin care are critical nursing considerations to ensure efficacy and prevent skin breakdown . More recently, the development of external urinary catheters for female patients has provided a promising new tool in the nurse's arsenal, offering a non-invasive method for managing urine output and protecting skin integrity .
- **Intermittent Catheterization:** For patients with chronic urinary retention or neurogenic bladder, intermittent ("in-and-out") catheterization is the preferred method over a long-term IUC. When performed at regular intervals to prevent bladder overdistension, it is associated with a lower risk of infection .
- **Portable Bladder Scanners:** This non-invasive technology is an indispensable nursing tool for preventing unnecessary catheterizations. A bladder scanner uses ultrasound to quickly and painlessly measure post-void residual (PVR) urine volume at the bedside. This allows the nurse to accurately diagnose urinary retention, differentiate it from other causes of low urine output, and avoid catheter placement if the bladder is not full .
- **Other Strategies:** A holistic approach to urinary management also includes less technological but equally important interventions. These include establishing a programmed or timed toileting schedule, utilizing urinals or bedpans, and using high-quality absorbent pads or briefs for incontinent patients, which can often manage urinary output effectively without the need for an invasive device

2.2 Aseptic Insertion: A Moment of Critical Importance

When an indwelling catheter is deemed necessary, the insertion procedure becomes a critical control point for infection prevention. This invasive procedure demands meticulous adherence to aseptic technique, as any breach can introduce microorganisms directly into the sterile urinary tract .

2.2.1 Adherence to Hand Hygiene and Sterile Technique

The principles of aseptic insertion are non-negotiable. The process begins and ends with thorough hand hygiene. A pre-packaged sterile catheterization kit should be used, and its contents must remain sterile throughout the procedure. This involves establishing a sterile field on a clean, appropriate surface—such as a bedside table, never the patient's bed—and donning sterile gloves . If at any point the catheter is accidentally contaminated by touching a non-sterile surface, it must be immediately discarded and replaced with a new sterile one. Observational studies have shown that significant breaks in aseptic technique are common, underscoring the need for constant vigilance . To mitigate this risk, a "buddy system," where a second person assists with patient positioning and maintaining the sterile field, is considered a best practice

2.2.2 Proper Perineal Care Prior to Insertion

Before inserting the catheter, the urethral meatus and surrounding area must be cleansed to reduce the microbial load. While various antiseptic solutions are available in commercial kits, systematic reviews have found no statistically significant difference in subsequent CAUTI rates between different cleansing agents, including chlorhexidine, povidone-iodine, sterile water, or simple soap and water. This suggests that the mechanical action of cleansing is the most important component. Nurses should follow their facility's established protocol while ensuring the area is thoroughly cleaned according to procedural guidelines .

2.2.3 Ensuring Catheter Securement

Immediately following successful insertion and balloon inflation, the catheter must be properly secured to the patient's body using a dedicated securement device . This step is crucial and is consistently included as a key process measure in CAUTI prevention audits. Proper securement prevents the catheter from migrating or being pulled, which can cause painful urethral traction, tissue trauma, and bladder neck erosion . This micromotion can also facilitate the entry of microorganisms along the extraluminal pathway. The catheter should be secured to the upper thigh in females or the upper thigh or lower abdomen in males, allowing for some slack to prevent tension during patient movement .

2.3 Diligent Maintenance: Preventing Infection Day by Day

Once the catheter is in place, the risk of infection grows daily. Diligent nursing care focused on maintaining the integrity of the system and promoting drainage is essential to mitigate this ongoing threat.

2.3.1 Maintaining a Closed Drainage System

A cornerstone of CAUTI prevention is the strict maintenance of a closed drainage system. The connection between the catheter and the drainage tubing should remain sealed at all times. Breaches in this system, such as unnecessary disconnections, create a direct portal of entry for microorganisms into the catheter's internal lumen, a known risk factor for bacteriuria . Some evidence suggests that pre-connected systems with tamper-evident seals may offer an advantage in maintaining this integrity . If the system becomes disconnected or compromised, the entire catheter and drainage system should be replaced using full aseptic technique .

2.3.2 Principles of Drainage Bag Management

Proper management of the urine collection bag is critical to prevent the reflux of contaminated urine back into the bladder and to avoid cross-contamination. Three principles are paramount:

1. **Positioning:** The drainage bag must always be positioned below the level of the patient's bladder. This simple gravitational principle is essential to ensure unidirectional flow of urine away from the bladder .
2. **Preventing Floor Contact:** The drainage bag must never be allowed to rest on the floor, a surface that is heavily contaminated with pathogens . Bags should be hung on the bed frame or a designated hook.
3. **Aseptic Emptying:** The bag should be emptied regularly, before it becomes completely full, using a dedicated, clean collection container for each patient. During emptying, the drainage spout must not touch the container or any other surface. The clinician must perform hand hygiene and don gloves before and after the procedure.

2.3.3 Evidence on Routine Meatal Hygiene

For patients with an indwelling catheter, ongoing perineal care is an important aspect of daily hygiene. Current evidence and clinical guidelines do not support the use of antiseptic solutions for routine daily meatal care . Instead, best practice is to perform routine cleansing of the meatal-catheter junction with simple soap and water during daily bathing or as needed. Vigorous cleansing should be avoided, as it can irritate the mucosa and potentially increase the risk of infection .

2.4 The Imperative of Timely Removal

While the preceding pillars focus on minimizing the risks associated with catheterization, the final and most impactful pillar is to eliminate the risk altogether by removing the device as soon as it is no longer medically necessary.

2.4.1 Daily Nursing Review of Catheter Necessity

Given that prolonged catheterization is the number one risk factor for CAUTI, a systematic process for daily review of catheter necessity is essential . Nurses are ideally situated to lead this process. During daily patient assessments and rounds, the nurse should re-evaluate the indication for the catheter against the established criteria for appropriate use . This active, daily review serves as a crucial reminder and prompts communication with the medical team to secure an order for removal when the indication is no longer valid . Without this proactive nursing assessment, catheters are often forgotten and left in place longer than necessary, a phenomenon sometimes referred to as "catheter amnesia" .

2.4.2 The Efficacy of Nurse-Driven Removal Protocols

To combat catheter overuse and streamline the removal process, many institutions have successfully implemented nurse-driven removal protocols. These protocols empower nurses to autonomously remove an IUC without a specific physician's order when predefined criteria are met . The evidence supporting these protocols is robust; numerous studies have demonstrated that their implementation leads to a significant reduction in catheter utilization days and a corresponding decrease in CAUTI rates. For instance, one study in a surgical trauma ICU found that implementing a nurse-driven removal protocol as part of a larger bundle decreased the CAUTI rate from 5.1 to 2.0 infections per 1000 catheter-days. These protocols often utilize a checklist or a mnemonic, such as HOUDINI (Hematuria, Obstruction, Urologic surgery, Decubitus ulcer, I&O critical, No code/comfort care, Immobility), to guide the nurse's daily assessment and decision-making . Empowering nurses with this autonomy is a powerful strategy to translate evidence into practice and directly improve patient safety.

3.0 Surveillance and Management: The Nurse's Role When Infection is Suspected

While prevention is the primary goal, nurses must also be adept at the early recognition and collaborative management of a suspected CAUTI. This reactive role requires sharp assessment skills, procedural precision, and clear communication to ensure timely diagnosis and treatment, thereby preventing complications.

3.1 Early Recognition and Vigilant Assessment

3.1.1 Identifying the Signs and Symptoms of CAUTI

Frontline nurses are best positioned to detect the subtle and overt signs of a developing CAUTI. This requires the ability to synthesize a constellation of data points, integrating new clinical signs with the patient's baseline condition and the primary risk factor of an indwelling catheter. The clinical presentation of CAUTI can be categorized into localized, systemic, and atypical signs.

- **Localized Signs and Symptoms:** These symptoms point directly to the urinary tract. The nurse should assess for new-onset suprapubic tenderness or pain upon palpation of the lower abdomen, as well as costovertebral angle (CVA) or flank tenderness, which may suggest ascending infection to the kidneys (pyelonephritis). Acute hematuria or pelvic discomfort can also be indicative of a CAUTI.
- **Systemic Signs and Symptoms:** Often, a CAUTI will manifest with systemic signs of infection. These include new-onset or worsening fever ($>38.0^{\circ}\text{C}$), rigors (uncontrollable shaking chills), malaise, or unexplained lethargy. The presence of these symptoms in a catheterized patient, with no other obvious source of infection, should immediately raise suspicion for a CAUTI.
- **Atypical Presentations in the Elderly:** A critical aspect of nursing assessment is recognizing that elderly patients may not exhibit the classic signs of a UTI. Their immune response may be blunted, and they may not mount a significant fever. Instead, a CAUTI in an older adult frequently presents with non-specific, often behavioral, symptoms. Nurses must be highly vigilant for signs such as new-onset or worsening delirium, confusion, agitation, a sudden decline in functional status, lethargy, loss of appetite, or an increase in falls. These changes in mental status or behavior can be the first and only indicators of a serious underlying infection.

3.1.2 The Nurse's Role in Surveillance and Reporting

Accurate institutional surveillance of CAUTI rates is foundational to any quality improvement effort, and it begins with the bedside nurse. Manual surveillance by infection preventionists is a labor-intensive process that relies heavily on the accurate and timely documentation of clinical signs and symptoms by nursing staff. When a nurse identifies a potential CAUTI based on the signs and symptoms described above, their clear documentation in the patient's record provides the essential data that allows infection prevention teams to apply the formal NHSN criteria. This partnership between frontline nurses and infection prevention specialists is crucial for identifying trends, targeting interventions, and meeting regulatory reporting requirements.

3.2 Collaboration in Diagnosis and Treatment

3.2.1 Proper Urine Specimen Collection

When a CAUTI is suspected based on clinical signs, obtaining a urine specimen for culture is the next critical step for confirming the diagnosis and guiding antimicrobial therapy. The validity of the culture result is entirely dependent on the quality of the specimen collection, making the nurse a gatekeeper for diagnostic accuracy. A poorly collected, contaminated specimen can lead to a false-positive result, misdiagnosis, and the unnecessary administration of antibiotics, contributing to antimicrobial resistance.

Best practice for obtaining a urine sample from an indwelling catheter is a strict aseptic procedure:

1. Perform hand hygiene and don clean gloves.
2. Clamp or crimp the drainage tubing just below the sampling port to allow fresh urine to collect in the tubing.
3. Thoroughly scrub the needleless sampling port with an appropriate disinfectant (e.g., 70% alcohol) and allow it to dry.
4. Using a sterile syringe, aseptically access the port and aspirate the required volume of urine.
5. Transfer the urine immediately into a sterile specimen container, label it appropriately, and ensure prompt transport to the laboratory or proper refrigeration.

It is imperative that a urine specimen is **never** collected from the drainage bag. Urine that has pooled in the bag is stagnant and contaminated with environmental bacteria, and a culture from this source will not accurately reflect the microbiology of the bladder.

3.2.2 Communicating Clinical Findings

Once a CAUTI is suspected and a specimen has been collected, clear and structured communication with the physician or advanced practice provider is essential to ensure a timely patient evaluation and initiation of treatment. The SBAR (Situation, Background, Assessment, Recommendation) framework is a widely endorsed communication tool that ensures information is conveyed concisely and completely, reducing the risk of miscommunication.

For a suspected CAUTI, a nurse's SBAR report might be structured as follows:

- **Situation:** "I am calling about Mr. Jones in room 204. He has a new-onset fever of 38.7°C and appears more lethargic than this morning."
- **Background:** "Mr. Jones is a 78-year-old male, postoperative day 3 from a hip replacement. He has had an indwelling catheter since surgery. His baseline mental status is alert and oriented."
- **Assessment:** "His vital signs are stable otherwise, but he has new suprapubic tenderness on palpation. There are no other obvious sources of infection. I am concerned he may have a CAUTI."
- **Recommendation:** "I have just collected a urine specimen for culture via the catheter port. I recommend that you come and assess the patient. Does he need a bolus of intravenous fluids, and should we consider starting empiric antibiotics pending the culture results?"

This structured approach presents a clear clinical picture and provides a direct, actionable recommendation, facilitating efficient and effective collaboration.

3.2.3 Administering and Monitoring Antimicrobial Therapy

Following a diagnosis and prescription for treatment, the nurse's role shifts to the administration of antimicrobial therapy and monitoring the patient's response. This includes ensuring the correct antibiotic is given at the prescribed time and via the correct route. Equally important is the ongoing assessment of the patient's clinical status. The nurse monitors for resolution of symptoms, such as defervescence and improvement in mental status, and vigilantly watches for any potential adverse effects of the medication. This continuous monitoring provides crucial feedback to the medical team regarding the effectiveness of the chosen therapy.

4.0 System-Level Supports and Interprofessional Collaboration

While individual nursing vigilance is the bedrock of CAUTI prevention, sustained success requires robust system-level supports and a culture of interprofessional collaboration. These organizational structures provide the tools, education, and collaborative environment necessary to hardwire evidence-based practices into daily workflow, transforming the efforts of individual nurses into a reliable, high-performing safety system.

4.1 The Power of CAUTI Prevention Bundles

A "bundle" is a structured set of three to five evidence-based interventions that, when implemented together for every patient, every time, result in significantly better outcomes than when the interventions are performed individually. The power of the bundle lies not just in the efficacy of its components, but in its function as a tool for creating reliability. By framing a set of critical tasks as an interconnected, all-or-nothing process, the bundle promotes a standardized approach and creates a system of shared accountability.

CAUTI prevention bundles typically incorporate key practices across the catheter's lifecycle. As outlined in Table 3, these bundles serve as a practical checklist for nurses and the entire care team. The evidence supporting this approach is strong. Numerous studies have demonstrated that consistent implementation of CAUTI prevention bundles leads to dramatic and sustained reductions in infection rates. For example, one study in an ICU setting found that adherence to a bundle intervention decreased the CAUTI rate from 3.84 to 1.31 per 1000 catheter-days and significantly reduced catheter utilization. Another quality improvement project in a coronary ICU used a bundle approach to achieve a CAUTI rate of zero for over 280 consecutive

days . The nurse is central to this success, responsible for ensuring compliance with every element of the bundle at the bedside, from using the insertion checklist to performing daily maintenance assessments .

Table 3: Core Components of a Multimodal CAUTI Prevention Bundle

Phase	Core Interventions
1. Pre-Insertion (Avoidance)	• Use of a checklist to verify appropriate, evidence-based indications before insertion . • Assessment for and use of alternatives to indwelling catheters whenever possible .
2. Insertion	• Adherence to a strict aseptic insertion checklist . • Hand hygiene before and after procedure. • Use of sterile gloves, drapes, and equipment. • Proper perineal cleansing prior to insertion.
3. Maintenance	• Daily review of catheter necessity with prompt removal when no longer indicated . • Adherence to a daily maintenance checklist: - Maintain a continuously closed drainage system . - Ensure proper catheter securement to prevent movement . - Keep the drainage bag below the level of the bladder and off the floor . - Maintain unobstructed urine flow (no kinks or dependent loops) .
4. Removal	• Implementation of a nurse-driven protocol for catheter removal . • Education and protocol for managing post-removal urinary retention to prevent re-insertion .

4.2 Education, Competency, and Feedback

4.2.1 The Importance of Ongoing Staff Education and Competency Validation

A successful CAUTI prevention program is built upon a knowledgeable and skilled workforce. It is not enough to simply have protocols in place; all healthcare personnel involved in catheter insertion and care must receive comprehensive, ongoing education on best practices . Effective educational strategies often employ a multimodal approach, combining online learning modules with in-person skills labs and simulations to accommodate different learning styles . Education should cover the entire spectrum of care, including catheter indications, alternatives, aseptic insertion, daily maintenance, and criteria for removal. Beyond initial education, competency must be regularly validated. This ensures that knowledge is translated into correct practice at the bedside. Competency validation can be achieved through direct observation of procedures, skills checklists, and return demonstrations, particularly for critical tasks like aseptic insertion

4.2.2 The Role of Audits and Performance Feedback

To drive and sustain improvement, performance must be measured and the results communicated back to the frontline staff. This creates a continuous feedback loop that is the engine of cultural change. Regular audits of key process measures—such as hand hygiene compliance, adherence to the insertion bundle, or proper catheter securement—provide objective data on how well the team is performing . For this data to be effective, it must be shared in a manner that is timely, individualized, and non-punitive . Feedback is most impactful when it is delivered frequently (at least monthly), comes from a respected peer or supervisor, and is presented clearly with established targets for improvement. Displaying unit-level data on run charts allows staff to visualize their progress over time . Furthermore, "just-in-time" coaching

provided by nurse champions or infection preventionists during audits offers an opportunity for immediate, real-time correction and reinforcement of best practices, which is a highly effective form of feedback.

4.3 Interprofessional Teamwork

CAUTI prevention is a team sport, requiring seamless collaboration among all members of the healthcare team . While nurses are at the center of implementation, their efforts are magnified when supported by physicians, infection preventionists, patient care technicians, and hospital leadership. A culture of safety is fostered when there is mutual respect, open communication, and a shared sense of responsibility for patient outcomes .

This synergy is evident in daily practice. For example, effective nurse-physician collaboration during daily rounds is essential for reviewing catheter necessity and making timely decisions for removal . Infection preventionists provide crucial expertise, data analysis, and education, while patient care technicians play a vital role in daily maintenance tasks like perineal hygiene and drainage bag emptying. Studies have shown that establishing a formal, interprofessional team dedicated to reducing HAIs is a highly effective strategy for driving improvement, as it breaks down professional silos and fosters a collective ownership of the problem .

4.4 Patient and Family Engagement

Patients and their families are often an untapped resource in the quest for patient safety . When educated and empowered, they can serve as active partners in their own care and as an additional layer of safety. The nurse's role is pivotal in facilitating this engagement.

This process begins with education, delivered using health literacy-sensitive strategies that avoid medical jargon and confirm understanding using techniques like "teach back" . Nurses should educate patients and their families on the reason for the catheter, the importance of hand hygiene for anyone touching the system, proper hygiene practices, and the key signs of infection to report immediately. Empowering patients and families to ask the simple but powerful question, "Is this catheter still needed today?" during daily rounds reinforces the team's focus on timely removal and makes the patient an active participant in the decision-making process .

5.0 Challenges, Barriers, and Future Directions

Despite a clear evidence base for CAUTI prevention, translating these best practices into reliable, everyday care remains a significant challenge. Success requires not only understanding the clinical interventions but also recognizing and addressing the complex human and systemic barriers that impede their implementation. Looking forward, the future of CAUTI prevention will likely involve leveraging technology to support human performance and continuing to refine nursing-led models of care.

5.1 Overcoming Barriers to Best Practice

The obstacles to consistent CAUTI prevention are often more social and cultural than technical. The most effective interventions—such as avoiding unnecessary catheterization and ensuring timely removal—are technologically simple but can be behaviorally complex to implement because they challenge ingrained habits and professional hierarchies. Common barriers include:

- **Cultural and Hierarchical Barriers:** A deeply rooted barrier is the traditional healthcare hierarchy. Studies have identified both "nurse deference to physicians" and "physician push-back" as significant impediments to the success of nurse-driven protocols. Nurses may feel hesitant to autonomously remove a catheter, even when a protocol allows it, for fear of overstepping perceived boundaries, while some physicians may resist what they see as an erosion of their authority .
- **Workload and Resource Constraints:** High nursing workloads, inadequate staffing levels, and a

lack of readily available resources can create an environment where shortcuts are taken. For example, without easy access to a bladder scanner or alternative urinary management supplies, an indwelling catheter may be placed or left in place for convenience .

- **Resistance to Practice Change:** Ingrained habits and a culture of "this is how we've always done it" can create significant resistance to new protocols. Overcoming this inertia requires persistent education, strong leadership, and clear communication about the rationale for change .
- **Patient and Family Influence:** Clinicians may face pressure from patients or their families who request an indwelling catheter for reasons of convenience or a mistaken belief that it provides better care. In these situations, nurses must use their communication and education skills to explain the significant risks associated with catheters and advocate for safer alternatives .

5.2 Innovations in Catheter Technology

In an effort to reduce the intrinsic risk of the device itself, manufacturers have developed catheters with advanced features. However, these technological solutions have not proven to be a panacea and should be considered adjuncts to, not replacements for, fundamental nursing care.

- **Antimicrobial-Coated Catheters:** Catheters coated or impregnated with antimicrobial substances, such as silver alloy or nitrofurazone, are designed to inhibit bacterial colonization and biofilm formation. While some in-vitro studies have shown promise, their clinical effectiveness remains a subject of debate. Current guidelines generally recommend that these catheters be considered only for select high-risk patient populations or in facilities with persistently high CAUTI rates that have not been controlled by implementing fundamental prevention strategies . Furthermore, some research suggests these coatings may only have a bacteriostatic effect, leading to the formation of viable but nonculturable (VBNC) bacteria, which could still pose an infection risk .
- **Catheter Materials:** The material from which a catheter is made can also influence its propensity for biofilm formation. Some studies suggest that pure silicone catheters may be less susceptible to bacterial colonization compared to silicone-coated latex catheters, potentially offering a marginal advantage .

5.3 The Future of CAUTI Prevention

The future of CAUTI prevention lies in better supporting human performance through technology and advancing nurse-led models of care. The most impactful innovations will likely be those that effectively address the behavioral and cultural dynamics that are the final barriers to success.

- **Enhanced Electronic Health Record (EHR) Integration:** The EHR can be a powerful tool to hardwire best practices into clinical workflow. Future developments will likely include more sophisticated clinical decision support tools, such as automated reminders for daily review of catheter necessity and electronic "stop orders" that require physicians to actively re-justify continued catheterization after a set period. A promising strategy already in use is the "Urine Culture Hard Stop," an EHR intervention that requires providers to meet specific clinical criteria or obtain an override from infection control before ordering a urine culture on a chronically catheterized patient, thereby reducing inappropriate testing and treatment of asymptomatic bacteriuria.
- **Predictive Analytics:** The use of predictive analytics and machine learning algorithms holds potential for identifying patients at the highest risk of developing a CAUTI upon admission or during their hospital stay. By analyzing vast amounts of patient data, these models could flag high-risk individuals, allowing for the deployment of more targeted and intensive prevention strategies by the nursing team.
- **Future Directions for Nursing-Led Research:** The evolution of CAUTI prevention is a dynamic process driven by research. A subtle but profound shift in philosophy is evident in the naming of new protocols like the "Urinary Catheter Alleviation Navigation Protocol (UCANP)". This terminology moves beyond the simple act of "removal" and reframes the nurse's role as one of

"navigating" the patient's transition away from catheter dependency, including proactively managing potential complications like post-removal urinary retention. Future nursing-led research is needed to further explore and validate such holistic models of care. Key areas for investigation include the long-term clinical and patient-reported outcomes associated with new female external catheter devices, the development of effective interventions to overcome the socio-adaptive barriers to implementing nurse-driven protocols, and the rigorous evaluation of nurse-led patient and family education programs on CAUTI rates and patient engagement metrics.

6.0 Conclusion

The prevention of catheter-associated urinary tract infections is not merely a quality improvement metric; it is a fundamental measure of safe, compassionate, and high-quality nursing care. As this review has demonstrated, CAUTIs are largely preventable events, and the clinician most critical to their prevention is the professional nurse. Through meticulous and relentless adherence to evidence-based practices, nurses stand as the ultimate guardians of patient safety against this common healthcare-associated harm.

From the initial, judicious decision to avoid catheterization, to the flawless execution of aseptic insertion, the vigilant provision of daily maintenance, and the unwavering commitment to timely removal, every nursing action matters. By embracing their roles as assessors, skilled clinicians, patient advocates, and leaders of the interprofessional team, nurses can dramatically reduce the incidence of CAUTIs. Empowering nurses with the knowledge, resources, and autonomy to lead these prevention efforts is the most effective investment a healthcare organization can make in eliminating preventable patient suffering, reducing mortality, and lowering healthcare costs.

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