GUIDE TO INFECTION CONTROL IN THE HEALTHCARE SETTING

Recommendations for The Prevention of Catheter-Associated Urinary Tract Infections

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Topic Outline

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DEFINITION

This document aims to examine the existing evidence comprehensively and offer a broader international perspective, with focused suggestions for addressing critical issues prevalent in low- and middle-income countries (LMICs). It emphasizes actionable recommendations presented concisely to aid acute-care hospitals in LMICs and high-income countries alike in implementing and prioritizing efforts to prevent catheter-associated urinary tract infection (CAUTI). We acknowledge the statements and recommendations from several previous guidelines, including those from the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), the Association for Professionals in Infection Control (APIC), and the 2022 update of the Practice Recommendation Strategies to Prevent CAUTIs in Acute-Care Hospitals.[1] The assessment of the quality of evidence was based on the criteria and scoring provided by the SHEA, IDSA, and APIC Consensus, when available.[1] This expert guidance document is sponsored by the International Society of Infectious Diseases (ISID).

KEY ISSUES

- CAUTI rates in LMICs exceed those in the USA. The International Nosocomial Infection Control Consortium (INICC) observed consistently higher CAUTI rates in LMICs over the past two decades. The INICC report from 2002 to 2005 indicated a CAUTI rate of 8.9/1,000 UC-days,[2] gradually reducing to 2.91 in the report covering data from 2015 to 2020,[3] but still far above CDC/NHSN. Consequently, there is a need to assess strategies to address this critical situation, particularly in LMICs.
- CAUTI rates in LMICs exceed those in the USA, as reported by the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN), with a median CAUTI rate of 1.3 per 1,000 urinary catheter (UC)-days in medical-surgical intensive care units (ICUs). [4]
- Costs associated with CAUTI vary globally, with reported costs in the USA, of $1,006.[5]
- Regarding the associated length of stay (LOS), pooling 630 ICUs from 2015 to 2020 of 45 LMICs, from Africa, Asia, Eastern Europe, Latin America, and the Middle East, with data from 204,770 patients, 1,480,620 patient-days, 637,850 UC-days, and 7,635 CAUTIs, LOS was as follows: 6.57 days for patients without healthcare-associated infections (HAIs), 24.41 days for those with CAUTI. Patients with two simultaneous HAIs experienced LOS ranging from 29.13 to 32.01 days, while those with all three types of HAIs (CAUTI + central line-associated bloodstream infection [CLABSI] + ventilator-associated pneumonia [VAP]) had a LOS of 33.53 days.[3]
- Regarding associated mortality. CAUTIs have a significant impact on healthcare, leading to increased mortality rates.[3] Pooling 630 ICUs from 2015 to 2020 of 45 LMICs, the mortality rates were as follows: 14.06% for patients without HAI, and 31.14% for those with CAUTI. Patients with two simultaneous HAIs experienced mortality rates ranging from 38.79% to 43.32%, while those with all three types of HAIs (CAUTI + CLABSI + VAP) had a mortality rate of 46.56%.[3]
- Regarding risk factors for mortality. Studies have documented that CAUTI is an independent significant risk factor for mortality. In a multicenter, multinational, multicontinental study involving 786 ICUs across 312 hospitals in 147 cities spanning 37 countries between 1998 and 2022, a total of 300,827 patients were followed during 2,167,397 patient-days, resulting in 21,371 HAIs. Multiple logistic regression identified the following mortality risk factors: CAUTI (adjusted odds ratios [aOR]:1.18; 95% CI= 1.10-1.28; p<.0001); CLABSI (aOR:1.84; 95% CI= 1.73-1.95; p<.0001); VAP (aOR:1.48; 95% CI= 1.41-1.55; p<.0001); medical hospitalization (aOR:1.81; 95% CI= 1.75-1.86; p<.0001); LOS, risk rises 1% per day (aOR:1.01; 95% CI= 1.01-1.02; p<.0001); female gender (aOR:1.09; 95% CI= 1.07-1.12; p<.0001); age (aOR:1.012; 95% CI= 1.011-1.0124; p<.0001); central line-days, risk rises 2% per day (aOR:1.02; 95% CI= 1.01-1.02; p<.0001); and mechanical ventilator (MV)-utilization ratio

(aOR:10.46; 95% CI= 10.07-10.86; p<.0001). Coronary ICU showed the lowest risk for mortality (aOR: 0.34; 95% CI= 0.18-0.64; p<.0001). [6]

KNOWN FACTS

Risk factors for CAUTI

- According to a systematic review, the duration of catheterization is the main contributing risk factor for CAUTI incidence.[7] Studies identified the following variables as risk factors for CAUTI: female sex,[8] age over 50 years,[9] increased days of catheterization,[10] increased LOS in ICU,[11] after a urological surgical procedure,[12] mobility issues,[13] diabetes,[14] hypertension,[15] and spinal cord lesions,[16] cerebrovascular disease,[13] level of education.[17] A study was conducted among patients with cesarean delivery; longer operative time and pregnancies complicated by sexually transmitted infections were associated with higher rates of CAUTI.[18]
- At LMICs a study, in a prospective cohort study conducted across 623 ICUs within 224 hospitals situated in 114 cities across diverse continents, encompassing a cohort of 169,036 patients over a cumulative observation period of 1,166,593 patient-days spanning from January 1, 2014, to February 12, 2022, the primary aim was to elucidate the incidence and elucidate risk factors associated with a CAUTI. The investigation unveiled a substantial CAUTI rate of 2.83 per 1,000 UC-days. Notably, the highest incidence was observed among patients utilizing suprapubic catheters, particularly prevalent in Eastern European and Asian regions, trauma and neurologic ICUs, and LMICs. Employing multiple logistic regression analysis, several statistically significant risk factors surfaced, including pre-CAUTI LOS (aOR=1.05; 95% CI= 1.05-1.06; p<.0001), UC device utilization ratio (aOR=1.09; 95% CI= 1.07-1.12; p<.0001), age (~~adjusted odds ratios [~~aOR~~]~~ 1.01; 95% CI= 1.01-1.02; p<.0001), female gender (aOR=1.39; 95% CI= 1.26-1.51; p<.0001), public-facility status (aOR=2.24; 95% CI= 1.66-3.01; p<.0001), and admission to neurologic ICUs (aOR=11.49; 95% CI= 6.92-19.11; p<.0001). These findings underscore the imperative for targeted, evidence-based interventions aimed at mitigating CAUTI incidence, thus augmenting the quality of patient care and clinical outcomes within healthcare settings.[19]

SUGGESTED PRACTICE

Necessary prerequisites.

- Conduct a risk assessment for CAUTI and establish a program across the organization aimed at identifying and discontinuing catheters that are no longer required.[20] (Quality of evidence: MODERATE). Establish and enforce an institutional policy mandating regular, typically daily, evaluations of the ongoing necessity for catheterization.[21] Instances could involve implementing automatic stop orders, which prompt a review of current indications and necessitate the renewal of orders to continue indwelling catheterization. Additionally, standardized reminders can be utilized to highlight persistent catheters alongside their current indications, tailored to either physicians or nurses. Nursing and medical personnel should conduct daily assessments during patient rounds to determine the ongoing necessity of catheter use.[22]
- Ensure the availability of suitable infrastructure to prevent CAUTI.[23] (Quality of evidence: LOW) Guarantee that each unit is equipped with the necessary supplies to adhere to best practices in managing urinary issues. This includes ensuring the availability of bladder scanners, supplies for non-catheter incontinence management (such as urinals, garments, bed pads, and skin products), male and female external UCs, and indwelling catheters. It is imperative to make non-catheter urinary management

supplies easily accessible for bedside use, like indwelling UCs. Additionally, ensure that the physical environment allows for the proper positioning of UCs with attached tubes, such as indwelling UCs and some external UCs, on beds, wheelchairs, and at appropriate heights without risk of kinking for patients both in their rooms and during transport.

- Offer and execute evidence-based protocols designed to manage various stages of the UC life cycle, including assessing catheter appropriateness, ensuring proper insertion technique, providing maintenance care, and promptly removing catheters when they are no longer necessary. (Quality of evidence: LOW) Customize and integrate evidence-based criteria for appropriate indications for indwelling urethral UC use, potentially incorporating them as standardized clinical decision support tools within electronic medical record ordering systems.[20]
- Make certain that only adequately trained healthcare professionals (HCP) conduct UC insertions, with ongoing evaluation of their competence.[24] Supervision by experienced HCP should be mandated when trainees are involved in catheter insertions and removals to mitigate the risk of infectious and traumatic complications linked to urinary catheterization.[25] Given the notably elevated rates of CAUTI associated with catheter insertions by trainees like medical students, educational programs may need to reconsider the stage of medical training and the specific trainees involved in UC insertions in patients, as opposed to relying solely on simulation-based training models.[26] (Quality of evidence: LOW)
- Guarantee the availability and convenient placement of supplies essential for maintaining the aseptic technique during UC insertion.[1] (Quality of evidence: LOW).
- Establish a structured method for documenting various aspects of the patient record, such as the physician's directive for UC placement, reasons for insertion, insertion details (including date, time, and personnel), nursing placement records, daily maintenance tasks, and removal specifics. Also, document removal criteria and reasons for continued use. Ensure standardized documentation for efficient data collection and quality enhancement, including accessible records of both UC insertion and removal. Utilize electronic systems with search capabilities whenever feasible. Consider implementing nurse-driven protocols for UC removal once the need for placement is resolved, integrating them into routine orders or as reminders during physician rounds. These protocols should outline exceptions, such as for postoperative urology patients or cases requiring urology consultation before removal, necessitating a physician's authorization.[1] (Quality of evidence: LOW)
- Ensure that there are enough well-trained HCP and technological resources available to support the monitoring of UC usage and its outcomes.[27] (Quality of evidence: LOW)
- Perform surveillance for CAUTI as required, based on facility risk assessment or regulatory requirements.[27] (Quality of evidence: LOW)
- Create a standardized method for urine culturing by implementing an institutional protocol that outlines suitable indications for both catheterized and non-catheterized patients.[28] Investigate incorporating these criteria into the electronic medical record and periodically review the reasons for requesting urine cultures as part of the CAUTI risk evaluation process.[29] (Quality of evidence: LOW)

Implementation of CAUTI prevention strategies

- **Multidimensional approach:** Numerous national, multinational, and multicontinental studies, employing a multidimensional approach, have been conducted, achieving a significant reduction in rates of CAUTI and mortality. All of them include six components: (a) bundle, (b) education, (c) surveillance of CAUTI, (d) monitoring compliance with recommendations to prevent CAUTI, (e) internal reports of CAUTI rates, and (f) performance feedback.[30] (Quality of evidence: LOW)

1. **Bundles:**

- Care "bundles" in infection prevention and safety are simple sets of evidence-based practices that, when implemented collectively, improve the reliability of their delivery and improve patient outcomes.[31]
- The INICC (2024) utilizes a bundle as part of its approach to reducing CAUTI rates, demonstrating effectiveness in Africa, Asia, Latin America, Eastern Europe, and the Middle East. A comprehensive strategy was implemented across 299 ICUs spanning 32 LMICs. The approach involved a nine-element bundle, coupled with educational initiatives, continuous surveillance of CAUTI rates and clinical outcomes, monitoring of compliance with bundle components, and regular feedback on performance. Assessments were conducted over various time intervals, from baseline through the intervention phases. The primary metric, CAUTI per 1,000 UC-days, exhibited a substantial decrease from 14.89 during the baseline period to 5.51 in the 2nd month (relative risk [RR]=0.37; 95% CI= 0.34-0.39; p<.001), 3.79 in the 3rd month (RR=0.25; 95% CI= 0.23-0.28; p<.001), 2.98 in the 4-15 months (RR=0.21; 95% CI=0.18-0.22; p<.001), 1.86 in the 16-27 months (RR=0.12; 95% CI=0.11-0.14; p<.001), and 1.71 in the 28-39 months phase. Statistical analyses, including two-sample t-tests and generalized linear mixed models with a Poisson distribution, confirmed the significance of these reductions. Over the duration of 978,364 patient-days, involving 150,258 patients and 652,053 UC-days, the intervention achieved an 89% reduction in CAUTI incidence without necessitating substantial financial investments or additional staffing. These findings underscore the feasibility and effectiveness of the approach in addressing CAUTI challenges across diverse ICU settings in LMICs.[32] (Quality of evidence: LOW)

2. **Education.**

- Train HCPs responsible for catheter insertion on proper CAUTI indication criteria.[1]
- Educate HCPs overseeing urinary catheter insertion, care, and maintenance on CAUTI prevention. This training should encompass alternatives to indwelling catheters and procedures for insertion, management, and removal.[33](Quality of evidence: LOW)
- Assess HCPs' proficiency in catheter use, care, and maintenance.[34] (Quality of evidence: LOW)
- Educate healthcare providers on the importance of urine culture stewardship and guide when to perform urine cultures. Consider mandating clinicians to specify a justified indication when ordering a urine culture. These indications should be evidence-based and tailored to the patient population.[35] Incorporate guideline-based reminders that are tailored to specific situations. While the CDC website offers a general example of suitable and unsuitable reasons for urine culture, literature provides various lists customized for specific clinical settings such as the ICU, emergency department, nursing home, and patients with or without catheters.[36]
- Host training sessions focusing on the proper technique for urine specimen collection, stressing the importance of promptly delivering samples to the microbiology laboratory, ideally within an hour. In cases where transportation to the laboratory might be delayed, it is recommended to refrigerate samples (for up to 24 hours) or employ preservative urine transport tubes.[1] (Quality of evidence: LOW)
- Before resorting to indwelling urethral catheter placement, clinicians should be educated to explore alternative bladder management methods, such as intermittent catheterization or external collection devices for both males and females, where appropriate.[1] (Quality of evidence: LOW)
- Ensure prompt sharing of data and timely delivery of reports to relevant stakeholders.[1] (Quality of evidence: LOW)

3. **Surveillance of CAUTI.**

- Utilize consistent surveillance methods and definitions to enable data comparison with benchmark standards, such as those published by the CDC/NHSN.[37] (Quality of evidence: LOW)
- Numerator: The count of CAUTIs within a monitored unit.
- Denominator: The total number of UC days for all patients with indwelling urethral catheters on the unit.

- CAUTI Rate Calculation: Utilize CDC/NHSN definitions by dividing the number of CAUTIs in each unit by the total number of UC-days, then multiply the result by 1,000 to express the measure as the number of CAUTIs per 1,000 UC-days.[37]
- Monitor CAUTI rates over a period to evaluate the ongoing effectiveness of prevention strategies.
- Risk Adjustment: Stratify CAUTI rates according to risk factors such as ward or clinical service line. Compare CAUTI rates across different patient-care units using historical data and CDC/NHSN data,[4] and the INICC data.[3]
- Monitor the Device Utilization Ratio (DUR) over time to detect any fluctuations, enabling comparisons at both hospital and unit levels. This serves as a proxy for assessing patient exposure risk. The DUR, a CDC/NHSN,[4] and INICC measure,[3] considers facility- and location-level factors influencing device use, calculated as the observed device-days divided by observed patient-days.

4. **Internal reporting of CAUTI rates.**

These performance measures are intended for internal hospital quality improvement efforts and may not directly meet external reporting obligations. They encompass both process and outcome measures, suitable for communication to senior hospital leadership, nursing leadership, and clinicians overseeing patients susceptible to CAUTI.[38] For future improvement, internal reporting can be strengthened by creating and honing metrics that emphasize the rate of urine culturing and adherence to urine collection techniques in both catheterized and non-catheterized patients. When offering internal reports as a benchmark, compare the CAUTI rates of the hospital against data from the CDC/NHSN,[4] and the INICC.[3] (Quality of evidence: LOW)

5. **Monitoring Compliance With Recommendations To Prevent CAUTI.**[39] (Quality of evidence: LOW)

Following are some examples:

1. Appropriate Use of Indwelling UCs:
    a. Numerator: Count of patients with documented appropriateness for having a UC.
    b. Denominator: Count of all patients with a UC.
    c. Outcome: Calculate compliance percentage by dividing the numerator by the denominator and multiplying by 100.
2. Hand Hygiene Compliance:
    a. Numerator: Count of times HCP performed hand hygiene before touching the UC.
    b. Denominator: Count of opportunities where HCP touched the UC.
    c. Outcome: Calculate compliance percentage by dividing the numerator by the denominator and multiplying by 100.
3. Aseptic Technique and Lubricant Usage:
    a. Numerator: Count of opportunities where HCPs inserted a UC using an aseptic technique and a single-use packet of lubricant jelly.
    b. Denominator: Count of opportunities where HCPs inserted a UC.
    c. Outcome: Calculate compliance percentage by dividing the numerator by the denominator and multiplying by 100.
4. Proper Securing of Indwelling Catheters:
    a. Numerator: Count of opportunities where HCPs secured indwelling UC after insertion.
    b. Denominator: Count of opportunities where HCPs inserted a UC.
    c. Outcome: Calculate compliance percentage by dividing the numerator by the denominator and multiplying by 100.
5. Maintenance of Closed Drainage System:

    a. Numerator: Count of patients with a UC and a collecting bag maintained as a closed drainage system.
    b. Denominator: Count of patients with a UC.
    c. Outcome: Calculate compliance percentage by dividing the numerator by the denominator and multiplying by 100.
6. Maintenance of Unobstructed Urine Flow:
    a. Numerator: Count of patients with a UC and unobstructed urine flow.
    b. Denominator: Count of patients with a UC.
    c. Outcome: Calculate compliance percentage by dividing the numerator by the denominator and multiplying by 100.
7. Positioning of Collecting Bag:
    a. Numerator: Count of patients with the collecting bag positioned below the level of the bladder at all times and not resting on the floor.
    b. Denominator: Count of patients with a UC.
    c. Outcome: Calculate compliance percentage by dividing the numerator by the denominator and multiplying by 100.
8. Regular Emptying of Collecting Bag:
    a. Numerator: Count of patients with the collecting bag regularly emptied, avoiding reaching 75% of the volume of the bag.
    b. Denominator: Count of patients with a UC.
    c. Outcome: Calculate compliance percentage by dividing the numerator by the denominator and multiplying by 100.
9. Minimization of UC Use and Duration:
    a. Numerator: Total number of UC-days.
    b. Denominator: Total number of patient-days.
    c. Outcome: Calculate the ratio of usage by dividing the numerator by the denominator.

6. **Performance feedback.** (Quality of evidence: LOW)

- In performance feedback sessions, Infection Prevention professionals (IPPs) present charts illustrating the monthly compliance levels of attending HCPs with infection prevention practices.[30]
- The infection control tool is essential for attending HCPs to identify areas for improvement when compliance with infection prevention practices is lacking. Utilizing the "observer effect" on HCPs' behavior, this approach effectively influences their practices to enhance efficiency.[40]
- This approach was designed to influence behaviors to achieve more effective implementation.[41]

Main approaches

Insertion of indwelling catheters

- **Only insert UCs when essential for patient care and keep them in place only for as long as the indications persist**. (Quality of evidence: MODERATE). Appropriate indications include
    - (1) UCs should be used perioperatively for specific surgical procedures, such as urologic surgery or those involving contiguous structures of the genitourinary tract, during prolonged surgeries, in cases of large-volume infusions or diuretics during surgery, or when intraoperative monitoring of urine output is necessary. However, it is crucial to remove catheters placed solely due to the duration of surgery (e.g., >3 hours) or for decompression for a specific surgical approach at the conclusion of the surgical case.
    - (2) In ICU patients, hourly assessment of urine output is essential when clinically adjusting therapies frequently, such as volume resuscitation, diuresis, and vasopressors. However, the

mere presence of ICU care doesn't warrant indwelling catheter placement; a specific clinical indication is still required.
    - (3) For the management of acute urinary retention, indicated by newly developed retention of urine with a postvoid residual bladder volume >500 cm^3 as detected by a bladder scanner, treatment is recommended if asymptomatic, or >300 cm^3 if symptomatic. Symptoms may include bladder pain or fullness, persistent urge to void, new incontinence or leaking, or being only able to have frequent small voids.
    - (4) Aiding in the healing process of open pressure ulcers or skin grafts is appropriate for certain patients with urinary incontinence when alternative supplies for protective wounds or incontinence management (such as external urinary catheters or wound dressings) are not feasible.
    - (5) Exceptions may be permitted by facilities as part of palliative and/or comfort care if catheter usage aligns with specific patient goals, such as reducing the need for frequent bed or garment changes or managing pain that cannot be well controlled. [42]
- **Consider exploring alternative methods for bladder management, such as intermittent catheterization or external collection devices for males or females, when appropriate**.[1] (Quality of evidence: LOW)
- **Use the appropriate technique for catheter insertion**.[1] (Quality of evidence: MODERATE)
- **Consider collaborating to assist with patient positioning and to monitor for potential contamination during catheter placement**.[43] (Quality of evidence: LOW)
- **Adhere to hand hygiene practices (following CDC or WHO guidelines) immediately before inserting the catheter and before and after any manipulation of the catheter site or equipment**.[1] (Quality of evidence: LOW)
- **Use an aseptic technique and sterile equipment when inserting catheters**.[1] (Quality of evidence: LOW)
- **Employ sterile gloves, drapes, sponges, and a sterile antiseptic solution to cleanse the urethral meatus and utilize a single-use sterile packet of lubricant jelly for insertion**.[1] (Quality of evidence: LOW)
- **Choose a catheter with the smallest possible diameter that ensures adequate drainage to minimize urethral trauma. However, when needed, explore alternative catheter types and sizes, especially for patients expected to have challenging catheterization, to lessen the chances of multiple, potentially traumatic catheterization attempts**.[1] (Quality of evidence: LOW)

Management of indwelling catheters

- Adhere to routine hygiene practices. While the issue of cleaning the meatal area with antiseptic solutions remains unresolved, emerging literature suggests the use of chlorhexidine before catheter insertion.[44] It's recommended to avoid alcohol-based products due to concerns about the alcohol causing drying of the mucosal tissues.[45] (Quality of evidence: LOW)
- After insertion, ensure indwelling catheters are adequately secured to prevent movement and reduce urethral traction.[46] (Quality of evidence: LOW)
- Ensure the continuous maintenance of a sterile, closed drainage system.[45] (Quality of evidence: LOW)
- When breaks in the aseptic technique, disconnection, or leakage occur, replace both the catheter and the collection system using the aseptic technique.[1] (Quality of evidence: LOW)
- To examine fresh urine, obtain a small sample by aspirating urine from the needleless sampling port using a sterile syringe or cannula adaptor after cleansing the port with disinfectant.[1] (Quality of evidence: LOW)

- Ensure prompt transportation of urine samples to the laboratory. If immediate transport isn't possible, contemplate refrigerating urine samples or utilizing sample collection cups with preservatives. Collect larger volumes of urine, such as for special analyses like 24-hour urine, aseptically from the drainage bag.[1] (Quality of evidence: LOW)
- Maintain unobstructed urine flow. (Quality of evidence: LOW). Encourage bedside caregivers, patients, and transport personnel to consistently keep the collecting bag positioned below the bladder level, avoiding placement on the floor. Ensure the catheter and collecting tube remain free from kinks to maintain proper urinary flow and reduce the risk of bladder stasis and infection. Empty the collecting bag regularly using individual containers for each patient and refrain from touching the draining spigot to the collecting container.[1]

Supplementary interventions

These additional approaches are advised for implementation in hospital locations and/or populations where CAUTI rates remain unacceptably high, even after the adoption of the essential CAUTI prevention strategies mentioned earlier.

- Create a protocol to standardize the diagnosis and management of postoperative urinary retention. This protocol should include guidelines for nurse-directed intermittent catheterization and the utilization of bladder scanners as suitable alternatives to indwelling urethral catheterization, when appropriate.[47] (Quality of evidence: MODERATE)
- If utilizing bladder scanners, clearly define their indications, provide training to nursing staff on their operation, and ensure disinfection between patients following the manufacturer's instructions.[1]
- Set up a system for analyzing and reporting data on catheter use and any adverse events resulting from catheter use. (Quality of evidence: LOW). Use the cumulative attributable difference to identify high-risk units or hospitals. Evaluate process and outcome measures, such as standardized utilization ratio and standardized infection ratio. Define and monitor catheter harm beyond CAUTI, including issues like catheter obstruction, unintended removal, catheter trauma, or reinsertion within 24 hours of removal.[48]

Not Advisable Interventions to Prevent CAUTI

- Regular utilization of catheters impregnated with antimicrobial or antiseptic agents.[1] (Quality of evidence: HIGH)
- Introducing an opening into a closed system.[1] (Quality of evidence: LOW)
- Conducting screening for asymptomatic bacteriuria in catheterized patients, except pregnant women and patients undergoing endoscopic urologic procedures associated with mucosal trauma.[1] (Quality of evidence: HIGH).
- Using catheter irrigation as a preventative measure against infection.[1] (Quality of evidence: MODERATE). When employing continuous irrigation to prevent obstruction, ensure the maintenance of a closed system.
- Regular administration of systemic antimicrobials as prophylaxis.[1] (Quality of evidence: LOW)
- Regularly changing catheters as a preventative measure against infection. (Quality of evidence: LOW). However, for patients with long-term catheters in place for more than 7 days, the replacement of the catheter may be considered at the time of specimen collection for urine testing to obtain a fresh sample.[49]
- Application of alcohol-based products to the genital mucosa.[1] (Quality of evidence: LOW)

Interventions Pending Resolution (Quality of evidence: LOW)

- Choosing between an antiseptic solution and sterile saline for meatal and perineal cleaning before catheter insertion.[44]
- Utilizing urinary antiseptics, such as methenamine, for the prevention of UTIs.[1]
- Separating patients with UCs in place spatially to prevent the transmission of pathogens that could colonize urinary drainage systems.[1]
- The standard of care for the routine replacement of UCs in place for more than 30 days as a measure for infection prevention.[1]
- Optimal practices for customizing and enhancing the implementation of CAUTI prevention and urine-culture stewardship from the adult acute-care setting to the pediatric acute-care setting.[1]
- Use of silver alloy hydrogel-coated (SAH) catheter.
    - In their study titled "Prevention of urinary tract infection using a silver alloy hydrogel-coated catheter in critically ill patients: A single-center prospective randomized controlled study," Zhao et al. (2024) examined the efficacy of a silver alloy hydrogel-coated (SAH) catheter +in preventing CAUTI among 132 critically ill ICU patients. Patients were randomly assigned to SAH catheter or conventional catheter groups. Results showed significant differences: On day 7, the positivity rate for urinary white blood cells was higher in the conventional catheter group (33.8% vs. 15.6%, p = 0.016). On day 10, rates of positive urine cultures (27.9% vs. 10.9%, p = 0.014) and CAUTIs (22.1% vs. 7.8%, p = 0.023) were higher in the conventional catheter group. On day 14, viable bacteria counts were significantly higher in the conventional catheter group at catheter tip ([3.21 +/- 1.91] x 10(6) cfu/mL vs. [7.44 +/- 2.22] x 10(4) cfu/mL, p< 0.001), balloon segment ([7.30 +/- 1.99] x 10(7) cfu/mL vs. [3.48 +/- 2.38] x 10(5) cfu/mL, p< 0.001), and tail section ([6.41 +/- 2.07] x 10(5) cfu/mL vs. [8.50 +/- 1.46] x 10(3) cfu/mL, p< 0.001). The study concluded that SAH catheters effectively reduce CAUTIs in critically ill patients.[50]

SUGGESTED PRACTICE IN UNDER-RESOURCED SETTINGS

Education: In LMICs there is a critical need to intensify educational initiatives, as evidenced by the following research studies. (Quality of evidence: LOW)

- Al-Sayaghi, K. M., et al. (2023) conducted an observational study titled "Healthcare workers' compliance with the CAUTI prevention guidelines: an observational study in Yemen. The research aimed to evaluate HCPs' adherence to CAUTI prevention guidelines during UC insertion. Utilizing a descriptive cross-sectional design, the study took place in hospitals across Sana'a City, Yemen, from March to December 2020. Eligible participants included nurses and physicians from governmental, teaching, and private hospitals. Data collection employed convenience sampling and a structured observational checklist tailored for the study. Findings revealed that nurses predominantly conducted UC insertions, with lacking written policies or procedures and in-service education departments in most hospitals. The overall compliance mean score was 7.31 out of 10, indicating 71% of HCPs exhibited high or acceptable compliance levels, while 29% demonstrated unsafe compliance levels. Particularly low compliance areas included maintaining aseptic technique throughout insertion, using single-use lubricant jelly packets, hand hygiene prior to insertion, and securing the catheter post-insertion. Gender, HCPs' working ward/unit, availability of written policies/procedures, and in-service education departments influenced compliance levels. The study concluded that while Yemeni HCPs demonstrated acceptable overall compliance, critical measures exhibited unsafe adherence. Urgent actions are warranted, including the development, implementation, and monitoring of national guidelines and institutional policies for CAUTI prevention. Additionally, regular in-service education, training programs, and ensuring access to necessary materials and supplies are deemed essential.[51]
- The study conducted by Zegeye et al. (2023) aimed to assess the knowledge, practice, and associated factors of CAUTI prevention among nurses at the University of Gondar Comprehensive Specialized Hospital in northwest

Ethiopia in 2021. Despite a significant burden, there was a lack of published scientific research on the subject in Ethiopia prior to this study. A total of 423 nurses were included in the institutional-based cross-sectional study, which utilized simple random sampling. Data were collected using self-administered questionnaires, analyzed using descriptive statistics, and further assessed through multivariable regression analysis. The results revealed that 37.7% of nurses had good knowledge of CAUTI prevention, while 51.8% demonstrated good practice. Factors associated with good knowledge included sex, work experience, working unit, training, and access to guidelines. Similarly, factors associated with good practice included sex, work experience, attitude, and knowledge of CAUTI prevention. It was concluded that efforts should be made to enhance both knowledge and practice among nurses to improve patient outcomes and maintain a healthy lifestyle.[52]

Multidimensional Approach. (Quality of evidence: LOW)
Numerous national, multinational, and multicontinental studies, employing a multidimensional approach, have been conducted in LMICs, achieving a significant reduction in rates of CAUTI and mortality. All of them include six components: (a) bundle, (b) education, (c) surveillance of VAP, (d) monitoring compliance with recommendations to prevent CAUTI, (e) internal reports of CAUTI rates, and (f) performance feedback. The following 7 studies were conducted applying this specific intervention:

1. Conducted in 11 adult ICUs in Argentina in 2004, the study revealed a significant reduction in the CAUTI rate following the intervention (21.3 vs 12.39 CAUTI/1,000 UC-days [RR= 0.58; 95 CI%= 0.39 to 0.86; p=.006]).[53]
2. Conducted in Pediatric PICUs across ten cities in six LMICs —Colombia, El Salvador, India, Mexico, the Philippines, and Turkey—in 2012, the study revealed a significant reduction in the CAUTI rate following the intervention (5.9 vs 2.6 CAUTI/1,000 UC-days [RR= 0.43 [95% CI= 0.21-1.02; p=.0344]).[54]
3. Conducted in adult ICUs across 40 cities spanning 15 LMICs—Argentina, Brazil, China, Colombia, Costa Rica, Cuba, India, Lebanon, Macedonia, Mexico, Morocco, Panama, Peru, the Philippines, and Turkey—in 2012, the study revealed a significant reduction in the CAUTI rate following the intervention (7.86 vs 4.95 CAUTI/1,000 UC-days [RR 0.63, 95% CI= 0.55-0.72; p=.0001]).[55]
4. Conducted in an adult ICU in Lebanon in 2013, the study revealed a significant reduction in the CAUTI rate following the intervention (13.07 vs 2.21 CAUTI/1,000 UC-days [RR= 0.17; 95% CI= 0.06-0.5; p=.0002]).[56]
5. Conducted in 13 ICUs across 10 hospitals in 10 cities of Turkey in 2013, the study revealed a significant reduction in the CAUTI rate following the intervention (10.63 vs 5.65 CAUTI/1,000 UC-days [RR= 0.53; 95% CI= 0.4-0.7; p=.0001]).[57]
6. Conducted in four ICUs in the Philippines in 2013, the study revealed a significant reduction in the CAUTI rate following the intervention (11.0 vs 2.66 CAUTI/1,000 UC-days [RR= 0.24; 95% CI= 0.11-0.53; p=.0001]).[58]
7. Conducted into 299 ICUs spanning 32 LMICs in 2024, the study revealed a significant reduction in the CAUTI rate following the intervention (14.89 vs 1.71 CAUTI/1,000 UC-days [RR=0.11; 95% CI=0.09-0.13; p<.001]).[32]

Bundle approach. (Quality of evidence: LOW)
According to seven research studies implemented by INICC, a package with the following nine components,[32, 53-58] was effective in significantly reducing the rates of CAUTI in LMICs

- I- Follow appropriate indications for indwelling UC use;[32, 53-58]
- II- Perform hand hygiene immediately before and after insertion or any manipulation of the catheter device or site;[32, 53-58]
- III- Use an aseptic technique and a single-use packet of lubricant jelly for insertion;[32, 53-58]
- IV- Properly secure indwelling catheters after insertion to prevent movement and urethral traction;
- V- Maintain the UC and collecting bag as a closed drainage system;[32, 53-58]
- VI- Maintain unobstructed urine flow;[32, 53-58]

VII- Keep the collecting bag below the level of the bladder at all times, and do not rest the bag on the floor;[32, 53-58]
VIII- Empty the collecting bag regularly, avoiding reaching 75% of the volume of the bag;
IX- Minimize UC use and duration of use in all patients.[32, 53-58]

SUMMARY

The empirical evidence delineated in this review incontrovertibly establishes that CAUTI rates in LMICs persist at a magnitude exceeding threefold that observed in high-income countries. The review systematically presents scientific insights regarding the efficacy of diverse interventions across all settings even in bundle and multidimensional approaches, distinguishing between proven effective measures, those demonstrated to be ineffective, and the prescription of supplementary measures specifically advocated for adoption in LMICs.

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