Catheter-Associated Urinary Tract Infections

Evidence-Based Practices for Nurses



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Mikel L. Gray, PhD, CUNP, CCCN, FAANP, FAAN

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A fellow in the American Academy of Nursing, Gray is past president of both the Society of Urologic Nurses and Associates and the Certification Board for Urologic Nurses and Associates. He has received awards for his contributions to urologic and wound, ostomy, and continence nursing, and was named the NACF Continence Care Champion for WOCN in 2004.

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Organizational Focus

Changes in reimbursement policies by the Centers for Medicare & Medicaid Services (CMS) have prompted acute care facilities to reexamine their policies regarding use of indwelling urinary catheters and programs to prevent catheter-associated urinary tract infections (CAUTI). Evidence shows that bacteriuria is highly prevalent in catheters that remain indwelling for a period of days to several weeks, and is inevitable when they remain indwelling longer than 30 days, but evidence also shows us that there are many ways healthcare providers can reduce their patients' risk of developing a CAUTI.

Scope of the problem

The urinary system is the most common site for all hospital-acquired conditions (HAC). The daily risk of a CAUTI for hospitalized patients is approximately 3%–7%; and urinary tract infections (UTI) account for about 40% of all HACs, also known as nosocomial infections (Cravens & Zweig 2000; National Center for Health Statistics 2004).

UTIs are the most common HAC in the ICU, medical or surgical inpatient hospital unit, or rehabilitation unit. More than 80% of these infections are associated with the use of an indwelling urinary catheter. CAUTIs lead to between 2.1 and 6.7 out of 1,000 catheter days in home care. Therefore, it is not surprising that CMS identified CAUTI as one of the conditions it will no longer reimburse for when patients acquire it while in the hospital (Beaver 2008).

Risk factors

Risk factors for CAUTIs arise from constitutional or health-related factors, and from the catheter itself. These factors are associated with an increased risk of CAUTI:

- Female gender
- Poor nutritional status
- Coexisting chronic illness
- Diabetes mellitus
- Renal insufficiency (creatinine > 2.0 mg/dL)
- Ureteral stent or nephrostomy tube

- Other sites of infection (pneumonia, sepsis, etc.)
- Immunosuppression

(WOCN Clinical Practice Continence Subcommittee 2009)

Other risks are posed by factors associated with catheter care and management, including:

- Length of time the catheter remains in place
- Urinary drainage that is not maintained as a closed system

(WOCN Clinical Practice Continence Subcommittee 2009)

Understanding CAUTIs

UTIs are an inflammatory response of the urinary epithelium to invasion by a pathogen (Schaeffer & Schaeffer 2007). Bacterial species are the most common pathogens resulting in UTIs, but some infections are occasionally associated with fungal species (usually *Candida albicans*) or parasites. Urinary infections can be divided into two forms:

- **Uncomplicated:** An uncomplicated UTI usually occurs in otherwise healthy community-dwelling women. It produces characteristic symptoms such as dysuria (burning and pain with urination), suprapubic discomfort, and frequent urination.

- **Complicated:** A complicated UTI occurs in patients with an abnormality of the urinary system or other health problem that compromises host defenses or treatment response.

CAUTIs are considered complicated because of the presence of an indwelling urinary catheter.

The indwelling urinary catheter is considered a foreign object in the lower urinary tract, which means a CAUTI differs from an infection occurring in the urinary bladder of a patient who is not catheterized (Leidl 2001). CAUTIs do not produce the usual symptoms seen with uncomplicated UTIs. In addition, CAUTIs are more likely to involve more than one bacterial species, and they are more likely to involve antibiotic-resistant species when they occur in patients in acute care or critical care settings.

CAUTIs tend to occur in a lower urinary tract that is already colonized with bacteria, especially when a catheter remains indwelling for a period of days to weeks. Patients with an indwelling catheter develop bacteriuria at a rate of 3%–10% per day, and the incidence approaches 100% within the first 30 days following catheter insertion (Lo, et al. 2008; Maki & Tambyah 2001).

The battle with biofilms

Indwelling urinary catheters provide an ideal location for the formation of a biofilm. A biofilm is a slimy, polysaccharide coating that adheres to the surfaces of the indwelling catheter. The biofilm can form on the retention balloon, the external surface of the catheter lying within the bladder, the internal lumen of the catheter, and the drainage eyes.

A biofilm is a remarkably complex structure; it is formed by the bacteria themselves, and it develops a primitive circulatory system that delivers nutrients to the bacteria within its structure and removes waste products. In the presence of a biofilm, bacteria move from a planktonic state, where they are susceptible to annihilation by an antibiotic, to a sessile state, where they become resistant to destruction by antibiotic drugs. In most cases, colonization of a catheterized lower urinary tract leads to biofilm formation without producing signs and symptoms of a UTI. This condition is clinically referred to as *asymptomatic* bacteriuria (Schaeffer & Schaeffer 2007).

Diagnosis of CAUTI

A CAUTI is diagnosed only when signs and symptoms of an infection coexist with evidence of bacteriuria (> 100,000 colony-forming units per ml [CFU/ml] and a host response to the presence of bacteriuria [diagnosed on urinalysis as pyuria]). Asymptomatic bacteriuria is not routinely treated in the catheterized patient, regardless of whether it occurs in the critical care unit, inpatient hospital unit, or long-term care facility.

Treatment should not occur even when asymptomatic bacteriuria coexists with pyuria. Patients with indwelling urinary catheters typically develop pyuria because of the inflammation associated with the presence of the catheter itself. Asymptomatic bacteriuria is treated only in highly selected cases, such as patients undergoing certain abdominopelvic or urologic procedures, or selected immunocompromised patients.

Signs and symptoms

Signs and symptoms of a CAUTI include the presence of two or more of the following:

- Fever (increase in body temperature > 2°F or 1.1°C)
- Flank, abdominal, or suprapubic tenderness
- Change in urine character
- Hematuria
- Sudden change in mental or functional status

(CMS 2005)

Criteria for Using Catheters

Since CAUTIs are associated with indwelling catheters, so the decision to insert a catheter should be made only when less-invasive bladder management options are not feasible. Further, since the risk of CAUTI increases the longer the catheter remains indwelling (Schaeffer & Schaeffer 2007), all catheters should be removed as soon as patients' conditions allow.

The decision to insert a catheter is usually made by a physician or nurse practitioner and should be based on solid indications. Many hospitals establish policies that state the indications for placement of an indwelling urinary catheter, and assist nurses to determine the reason a specific catheter was placed, as well as to consult with the physician when a catheter has been placed without a clear indication.

Guidance for the placement of long-term indwelling catheters (those anticipated to remain in place for 30 days or longer) are:

- Urinary retention associated with bladder outlet obstruction that cannot be managed by other methods
- Urinary incontinence coexisting with urinary retention that cannot be managed by other methods

- Delayed healing of a high-stage pressure ulcer owing to urinary incontinence
- Palliative care settings where routine toileting is compromised by pain or immobility

(CMS 2005)

Guidance for short-term indwelling urinary catheters is not as well standardized. Nevertheless, commonly accepted indications for catheterization in the acute or critical care setting include:

- Urinary drainage following urologic, gynecologic, neurologic, or abdominopelvic surgery
- Monitoring urine output in acute or critically ill patients
- Monitoring core body temperature in critically ill patients
- Urinary drainage in patients with urinary retention

An indwelling urinary catheter should never be inserted to manage urinary incontinence that can be managed by other means, to reduce bed linen use, or for staff convenience.

Selecting the Optimal Catheter

Although the decision to insert an indwelling catheter is usually made by a physician or nurse practitioner, the nurse typically decides the type of catheter to be inserted and the associated urinary drainage system. Considerable clinical evidence exists demonstrating that multiple characteristics of the indwelling catheter influence the likelihood of urethral inflammation, patient discomfort, and the risk for CAUTIs. These characteristics include the material of construction, catheter size, and use of a catheter securement system.

Material of construction

Indwelling catheters are made from several materials, including latex and silicone. Latex may be coated with polytef particles to prevent excessive water absorption, or may be coated with a hydrogel that absorbs a limited volume of water while reducing the friction coefficient as the catheter interacts with the mucosa of the urethral lumen. Other catheters are made entirely of silicone or a silicone coating is applied to a latex catheter. Although existing evidence is sparse, it suggests that none of these materials prevent asymptomatic bacteriuria or CAUTIs (Garibaldi, et al. 1982; Parker, et al. 2009). Nevertheless, limited research supports the prevailing clinical wisdom that hydrogel-coated latex catheters and silicone catheters produce less urethral irritation and discomfort than catheters constructed of latex impregnated with polytef particles, especially when the catheter will remain indwelling for more than three to four days (Gray 2006).

More recently, indwelling catheters have been coated or impregnated with antiseptic or antimicrobial materials to retard bacterial colonization of the lower urinary tract and prevent CAUTIs. Two types of antimicrobial catheter are available in the United States: hydrogel-coated latex catheters coated with a silver alloy, and all-silicone catheters impregnated with the antibiotic agent nitrofurazone. Robust evidence summarized in several systematic reviews and meta-analyses demonstrates that these coatings reduce the incidence of bacterial colonization and CAUTIs within a seven- to 14-day period (Parker, et al. 2009; Schumm & Lam 2008; Johnson, Kuskowski, & Wilt 2006; Dunn, et al. 1999).

While most of the studies are based on the incidence of bacteriuria rather than CAUTIs, nurses should recognize that although bacteriuria is not a sensitive indicator of CAUTIs, it has considerable specificity for the diagnosis of symptomatic CAUTIs. Therefore, it seems reasonable to conclude that selection of a catheter capable of reducing the incidence of bacteriuria will also reduce the incidence of CAUTIs.

Although current clinical evidence shows that certain antiseptic catheters reduce bacteriuria, it also demonstrates that not all catheters are equally effective. For example, catheters coated with a silver alloy have been found to be more effective than those coated with silver oxide. Silver alloy catheters have also been shown to provide protection for up to two weeks, whereas all-silicone catheters impregnated with nitrofurazone have been shown to reduce the incidence of bacteriuria for up to seven days. Neither of these antiseptic catheters have been proven to prevent CAUTIs in patients managed by long-term indwelling catheterization (Parker, et al. 2009).

Catheter size

The Centers for Disease Control and Prevention's (CDC) clinical practice guidelines for preventing CAUTIs recommend selection of a smaller catheter size to reduce the risk (Wong & Hooton 1981). Larger catheters (especially size 18 French or larger) create more irritation and inflammation within the urethra, possibly increasing the risk of CAUTIs.

A review of the literature does not reveal any studies that have specifically evaluated the effect of catheter size on the risk of CAUTIs. However, clinical experience suggests that smaller catheter sizes (14–16 French in adults) are preferable to larger French sizes because they improve comfort and reduce urethral irritation without producing obstruction.

Catheter securement systems

A catheter securement device is designed to prevent excessive traction of the catheter against the bladder neck or inadvertent catheter removal (Gray 2008). Several types of devices are used to secure indwelling urinary catheters. Some clinicians use tape, gauze, and/or safety pins to create an ad hoc securement device. Manufactured devices include leg straps that typically incorporate Velcro, or adhesive-backed devices that can be attached to the thigh or abdomen.

The CDC strongly recommends use of a securement device to reduce urethral irritation and trauma for the prevention of CAUTIs. However, a review of the literature reveals only a single randomized clinical trial comparing a manufactured, adhesive-backed securement device to other manufactured devices and to no device (Darouiche, et al. 2006). No difference in the incidence of CAUTIs was found when the manufactured, adhesive-backed device was compared to other devices or to no device. Despite these findings, a review of available evidence concerning the use of securement devices concluded that securement should be considered a routine part of catheter management (Gray 2008). This conclusion was based on the efficacy of the device in preventing inadvertent traction and trauma against the bladder neck or accidental, traumatic catheter removal rather than prevention of CAUTIs.

Sterile Technique for Catheterization

The CDC (Wong & Hooton 1981) strongly recommends sterile technique during catheterization, as do clinical practice guidelines from SUNA (Society for Urologic Nurses and Associates 2005), but the Joanna Briggs Institute guideline (2000) states that existing evidence does not support the use of sterile technique. These apparent differences are influenced by different definitions for "sterile technique," and two appear to be based on expert opinion (Wong & Hooton 1981; Society for Urologic Nurses and Associates 2005) whereas the third (Joanna Briggs Institute 2000) is based on limited clinical evidence. A review of the literature on this topic reveals three studies comparing bacteriuria or CAUTI rates using sterile versus clean technique, or differing levels of rigor in the application of principles of sterile technique to indwelling urinary catheterization (Carpeti, Bentley, & Andrews 1994; Pickard & Grundy 1996; Webster, et al. 2001).

The results of these studies suggest that strict aseptic technique—donning sterile gloves, mask, and gown; placing sterile barriers over the genital area; cleansing the perineal area with an antiseptic solution; and employing a no-touch insertion technique—does *not* affect the risk for CAUTIs within the first 24–48 hours following catheterization. Handwashing before catheter insertion, and the use of the modified sterile technique outlined in the CDC guideline (donning sterile gloves, placing a drape over the genital area, and cleansing the perineal area using an antiseptic solution) is strongly recommended when inserting any indwelling catheter. Labeled sterile by CDC and SUNA guidelines, this approach would be described as a form of clean technique by many others.

Cleansing the urethral meatus

Daily cleansing of the urethral meatus, sometimes called "catheter care," is recommended to reduce bacterial colonization at the urethral meatus and diminish the likelihood that bacteria will ascend the urethra and cause CAUTI. Multiple techniques for urethral cleansing have been recommended, such as simple cleansing with a perineal or incontinence cleanser, but more extensive techniques have also been advocated. These techniques typically require cleansing followed by application of a variety of antimicrobial ointments or antiseptic solutions.

A nursing research study found that absence of daily meatal cleansing increased the relative risk of CAUTIs, especially among patients with fecal incontinence (Tsuchida, et al. 2008).

Four additional studies were located that compared daily or twice-daily cleansing to cleansing followed by application of a povidone-iodine or neomycin-polymyxin-B bacitracin ointment

(Burke, et al. 1981; Burke, et al. 1983; Koskeroglu, et al. 2004; Matsumoto, et al. 1997). Evidence from these studies reveals that daily or twice-daily cleansing plus application of an antimicrobial solution or ointment does not reduce the incidence of bacteriuria when compared to cleansing alone. Instead, results from two of these studies (Burke, et al. 1981; Burke, et al. 1983) revealed a slightly *higher* rate of bacteriuria among patients managed by the more complex meatal cleansing protocol. A fifth study (Classen, et al. 1991) compared routine meatal care with meatal care and disinfection of the outflow tubing using a povidone-iodine solution. Similar to the previous studies, no differences in bacteriuria rates were found when this protocol was compared to meatal cleansing combined with a standard sealed urinary drainage system. A final study was located that compared cleansing alone with cleansing followed by application of a silver sulfadiazine cream, but the addition of a silver-based antimicrobial cream also failed to reduce bacteriuria rates when compared to cleansing alone (Huth, et al. 1993).

Cumulative evidence from these studies clearly demonstrates that meatal cleansing should be done on a daily basis, particularly in patients with fecal incontinence. A perineal cleanser or soap and water should be used to cleanse the meatus and to remove visible debris from the exposed catheter. The application of antiseptic solutions or ointment should be avoided since it may increase the risk of bacterial colonization of the urethra, with subsequent bacteriuria and a potentially enhanced risk of CAUTI.

Selecting an Optimal Urinary Drainage System

Features of the urinary drainage system also influence CAUTI risk. The strongest evidence supports maintenance of a closed urinary drainage system for all short-term indwelling urinary catheters (Willson, et al. 2009). A closed drainage system is one that maintains a closed seal between the catheter and drainage tubing, and the drainage tubing and drainage bag. A distal mechanism must be intermittently opened to drain urine from the bedside bag, but this port is opened only when indicated, resealed after the drainage bag is emptied, and maintained away from direct contact with the floor.

Two studies (Platt, et al. 1983; DeGroot-Kosocharoen, Guse, & Jones 1988) have evaluated whether a presealed urinary drainage system provides greater protection than a urinary drainage system that is assembled at the time of catheter insertion. Presealed urinary drainage systems are available from several manufacturers. These systems typically contain a catheter, drainage tubing, and bedside urinary drainage bag. A plastic seal is molded over the junction between the catheter and the drainage tubing, allowing catheterization without exposing the catheter's distal end or the proximal end of the drainage system to the air or environmental surfaces. Evidence from these studies was mixed. One reported a statistically significant and clinically relevant advantage to the use of a preconnected catheter and urinary drainage system (Platt, et al. 1983), and the other found no significant differences in bacteriuria rates when the two systems were compared (DeGroot-Kosocharoen, Guse, & Jones 1988). Of note is the fact that the study that reported a lower rate of bacteriuria in patients managed with a preconnected sealed urinary drainage system also found that clinicians were 2.7 times less likely to intentionally open the closed system as compared to those randomized to the traditional system. This observation suggests that a preconnected system may protect against CAUTIs because it discourages clinicians from opening an otherwise closed system rather than acting as a physical barrier to the entry of bacteria into the urinary drainage system.

A variety of other design features have been proposed in an attempt to reduce CAUTI rates (Maki & Tambyah 2001; Willson, et al. 2009). Perhaps the most attractive of these is the use of an antireflux mechanism designed to prevent urine from moving in a retrograde manner from the drainage bag back into the collection tubing and (ultimately) the bladder vesicle (Maki & Tambyah 2001). Advice regarding selection of a urine drainage bag with an antireflux mechanism may be combined with education on the adverse effects of raising the urinary drainage bag above the level of the bladder vesicle for a prolonged period of time. This maneuver is avoided because it prevents normal drainage of urine from the bladder to the bag, and it promotes retrograde movement of urine from the bag toward the bladder. A literature review reveals no direct research linking CAUTI risk with the position of the urinary drainage bag; nevertheless, knowledge of bacterial colony counts in urinary drainage bags provides an excellent rationale for this commonly advocated best practice strategy (Lo, et al. 2008; Maki & Tambyah 2001; CMS 2005).

Bladder Irrigation Solutions

Bladder irrigation has also been explored as a method of preventing CAUTIs. Several solutions have been evaluated, including saline, antimicrobial solutions containing polymyxin and neomycin, and dilute acetic acid solutions. Literature review reveals a comparatively recent study of community-dwelling spinal cord–injured patients randomized to one of four irrigation solutions (Waites, et al. 2006). Although completed in an outpatient setting, this study illustrates several important points about the effect of routine bladder irrigation on patients with indwelling urinary catheters. Most importantly, none of the irrigating solutions proved effective in reducing bacteriuria rates or the incidence of CAUTIs after twice-daily irrigations over a period of eight weeks. In addition, a significant portion of the subjects failed to complete the study, owing to adverse side effects associated with irrigation or difficulty adhering to the twice-daily irrigation schedule.

Based on this combination of absence of efficacy of irrigation and risk for adverse side effects, which included bladder spasms and urinary infections despite irrigation, this practice cannot be recommended.

Preventing CAUTIs in Long-Term Indwelling Catheters

The vast majority of indwelling catheters encountered in the acute care setting are inserted for a period of two weeks or less and are classified as short-term. However, nurses practicing in acute and critical care settings also care for patients with long-term indwelling catheters. As noted previously, these catheters remain in for at least 30 days, and many remain in for many months or even years. The care of a patient with a long-term indwelling catheter differs from short-term care, and these differences influence the elements of an effective prevention program (Parker, et al. 2009; Willson, et al. 2009). For example, maintenance of a closed urinary drainage system is effective for short-term catheterization; this is not feasible for long-term indwelling catheters because of the need to switch from a larger, overnight drainage bag to a smaller leg bag or belly bag while the patient is awake and active.

Similarly, even though substantial evidence supports the efficacy of antimicrobial catheters for seven to 14 days, there is insufficient evidence to conclude that they are effective for preventing CAUTIs in patients managed by long-term indwelling catheters.

Although not a relevant concern in the short-term catheter, current evidence suggests that the frequency of catheter change influences CAUTI risk among patients with long-term indwelling catheters (Willson, et al. 2009). Literature review identified three studies that examined the influence of catheter change frequency on the risk of CAUTIs (Ho, et al. 2001; White & Ragland 1995; Priefer, Duthie & Gambert 1982). Results of these studies provide limited evidence that routine catheter changes, completed every four to six weeks, reduce CAUTI risk more than changing the catheter only when blockage occurs. Changing the catheter every four to six weeks is also associated with a lower frequency of CAUTIs than changing the catheter every two weeks or less.

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This is to certify that

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has read and successfully passed the final exam of

Catheter-Associated Urinary Tract Infections: Evidence-Based Practices for Nurses

Rob Stuart
Senior Vice President/Chief Operating Officer