

Catheters Used for Intermittent Catheterization

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Definition

Intermittent catheterization (IC) is a manual bladder-emptying technique. Either the patient or a caregiver inserts a catheter via the urethra, drains the bladder, and removes it once all urine is drained. IC usually occurs 4–6 times a day. This method of catheterization is an effective long-term bladder management strategy for individuals who have urinary retention or in those patients with incomplete bladder emptying. IC can be performed by patients of different age groups, including older adults and children starting from 4 years old under parental supervision. It offers the patient the ability to maintain independence because the patient has the choice of when and where to empty the bladder and perform bladder self-care.

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Indications: (Urinary Retention and NLUTD)

Bladder management in neurogenic lower urinary tract dysfunction (NLUTD) requires an understanding of lower urinary tract pathophysiology, critical to developing an optimized plan for long-term management. The goal is to ensure complete bladder emptying before the occurrence of high-pressure, uncoordinated involuntary detrusor contractions and other complications.

Symptoms of NLUTD include urinary incontinence (UI) or incomplete bladder emptying caused by outlet obstruction, ineffective detrusor contractions, or decreased compliance. Draining the bladder at regular intervals throughout the day reduces bladder pressure and improves circulation to the bladder, thus making the bladder urothelium more resistant to infectious bacteria [1].

Lower urinary tract symptoms (LUTS) are common in patients with neurologic disorders or conditions with neurological complications. NLUTD is prevalent in the spinal cord injury (SCI) population (50–80%), but severity of LUTS depends on the level and completeness of spinal cord involvement. Twenty percent of SCI patients have been identified as having urinary retention and 25% have been diagnosed with detrusor sphincter dyssynergia, which can lead to incomplete bladder emptying. The actual number of SCI patients who have these symptoms is likely higher.

Intermittent catheterization remains the treatment of choice for many patients with difficulty emptying their bladder due to neurogenic and non-neurogenic causes because it is widely available and minimally invasive [2]. IC has become the standard of care for persons with SCI and NLUTD who have adequate hand function or caregiver support. According to the Neurologic Urinary and Faecal Incontinence Committee 10 of the Sixth International Consultation on Incontinence 2017, “the mainstay of treatment in current practice is IC undertaken by the patient or carer” and is the treatment of choice where there is a significant post-void residual (PVR) [3]. A major goal of an IC program is to ensure complete bladder emptying

before the occurrence of high-pressure, uncoordinated, involuntary detrusor contractions. This requires a team approach involving educators, clinicians, therapists, social workers, and family members or caregivers [4]. The bladder management plan should be continually adjusted based on evolving patient needs and circumstances.

Although patients may follow a set schedule for performing self-catheterization, an increase in fluid intake can change intervals between catheterization. Thus, when patients or clinicians ask about the correct timing for performing IC, these individuals should be redirected to think about bladder management in terms of appropriate volume intervals. Catheterization should be timed such that the bladder is emptied before the volume at which high-pressure involuntary bladder contractions develop. Conversely, however, persons on an IC program must not go for a prolonged period without emptying the bladder, as urine stagnation and heavy bacterial growth can occur.

Methods

Clean intermittent self-catheterization (CISC), also referred to as intermittent self-catheterization (ISC), clean intermittent catheterization (CIC) or intermittent catheterization (IC) are bladder management techniques used to drain urine from the bladder with subsequent immediate removal of the catheter once all urine is drained [5]. CISC requires the patient performing the catheterization use clean technique (no gloves), ordinary hand washing or hand sanitation with prompt removal of the catheter. The patient should use a single-use (disposed after use) catheter as multiple-use (reused for multiple catheterizations) cleansed catheter is no longer recommended. Ensuring patient adherence to ISC techniques is imperative for prevention of long-term complications [6]. Patients must remain vigilant in the use of clean technique and must catheterize (“cath”) at intervals sufficient to avoid elevated bladder pressures (reducing the risk of vesicoureteral reflux and subsequent damage to the kidneys) and to prevent urinary leakage. Contrary to the hospital and institutional settings, where sterile technique is mandated, clean technique is the standard of care for persons living in the community [1].

The International Continence Society defines CISC as the use of a clean technique to drain the bladder with subsequent removal of the catheter performed by the patient. Clean technique implies the use of a clean technique and involves ordinary washing/cleansing techniques, and the use of disposable catheters [7]. Table 2.1 provides terminology used for IC [2, 5]. Shamout and colleagues [8] note that even with guidelines from international professional organizations, most clinicians use “their clinical judgment to determine which technique and type of catheter to use.”

History of Intermittent Catheterization

The technique of sterile IC was first used following World War II by Sir Ludwig Guttmann, in the bladder management of SCI patients. Guttmann and Frankel [7] proposed that routine bladder emptying was more physiologic and would provide better outcomes than indwelling catheters.

In 1972, urologist Dr. Jack Lapides introduced clean intermittent catheterization, since referred to as CIC, as a safe method of bladder emptying with low infection incidence. Dr. Lapides described a nonsterile technique for reusing a catheter for multiple catheterizations that involved sterilization of the catheter by soaking for 20 minute (min) before reuse.

IC is the preferred method of bladder management in the SCI population with LUTD and other conditions that cause incomplete bladder emptying [9]. IC is often referred to as the gold standard and is used to protect the bladder and kidneys by preventing over distention and urinary tract infections (UTI).

IC is favored over indwelling urethral or suprapubic catheters (IUC) because of evidence that it decreases the incidence of urinary tract infection (UTI) [10, 11]. IC has also been found to be associated with a lower occurrence of candiduria [12].

IC is considered a safe procedure with a lower rate of certain complications such as penile trauma and traction injuries or traction hypospadias, as compared to an IUC [11]. Ercole et al. [13] reported that CIC was associated with lower rates of UTI and complications of the lower urinary tract when compared to an indwelling catheter. The study also found a lower incidence of UTIs when sterile IC was compared to clean technique (see Table 2.1 for definitions of sterile and clean technique).

IC may be performed using sterile technique, but clean technique (CIC) is more commonly used. IC should be performed every 4–6 hours (h). Persons with spinal cord injuries and disorders (SCI&D) using IC need to catheterize frequently enough to keep volumes lower than predetermined levels defined by urodynamic studies. Generally, the urodynamic goal is a storage pressure lower than 40 centimeter (cm) H₂O [14]. Further studies are needed to determine the relative importance of management variables in influencing the rate of UTIs for those who perform IC.

IC is not for everyone, and a patient must first be assessed to determine if he or she is a good candidate. Assessment should determine if the person has a suitable bladder capacity and sufficient arm and hand dexterity, vision, cognition, and motivation to carry out the procedure [14]. In an IC program, the bladder acts as a reservoir for urine, so it is important that the person has reasonable bladder capacity. The greater a patient’s ability to store urine at safe pressures and without leaks, the greater chance the person has of success with IC. Adults who have small bladder capacity

Table 2.1 Intermittent catheterization terminology and definitions

Terminology	Definition
Sterile	<ul style="list-style-type: none"> Usual technique in environments such as hospitals, use of sterile catheterization tray or kit that includes: sterile gloves, genital disinfective, single-use catheters, sterile drainage collector
Aseptic	<ul style="list-style-type: none"> Use of sterile gloves, single-use catheter, preceded by disinfecting the genitalia with an antiseptic solution, and without direct manual contact with the catheter (e.g., no touch technique, sterile lubricant or pre-lubricated catheter)
Intermittent self-catheterization (ISC)	<ul style="list-style-type: none"> Implies the patient is catheterizing on a schedule determined by drained bladder volume A single-use catheter (e.g., external lubricant or pre-lubricated gel, hydrophilic) with a non-antiseptic solution for cleaning hands and perineum If a single-use catheter is reused, there is no evidence-based research on the best method for cleaning and storing the catheter between uses If a caregiver (parent catheterizing a child) is performing the catheterization gloves are used
No-touch	<ul style="list-style-type: none"> Sterile all-inclusive type of catheter system inside a protective sleeve or collection bag or product packaging may be used to hold the catheter during insertion No additional supplies are needed for sterile catheterization technique
Clean catheterization	<ul style="list-style-type: none"> Technique that implies hand washing with soap and water, and cleansing the genitalia only if fecal or other wastes are present If a caregiver (parent catheterizing a child) is performing the catheterization gloves are used

(100–200 milliliter (ml)) are not usually considered suitable for IC [14, 15]. IC requires a commitment to catheterize up to 6 times a day or more if needed. The person has to be dedicated to IC and must carry catheters and associated supplies when away from their home. IC takes longer than simply voiding, and the person may develop infections, bleeding, or trauma. Women who are chair fast (e.g., in a wheelchair) may find the procedure difficult or spill urine when catheterizing [14], so male length catheters or those with integrated bags could be considered in those cases.

Advantages of Intermittent Catheterization

Optimal management of the lower urinary tract is important in patients with NLUTD to prevent damage to the upper urinary tract and preserve renal function. Intermittent catheterization can be a practical and effective method of bladder management and is usually performed by the patient or their caregiver. Advantages of IC include avoidance of complications that can occur with indwelling catheters. These include: catheter-related trauma, urethral traction injury/hypospadias, and dilation of the bladder neck with subsequent leakage at low pressures. IC eliminates the need for tubing, leg bags, or bed-

side drainage bags and creates the freedom to wear shorts or skirts without exposed devices. IC has a lower risk of bladder stones or cancer than with an indwelling catheter. Not having a catheter in the urethra is also an advantage for persons who wish to be sexually active.

Characteristics of Intermittent Catheters

There are a wide variety of urinary catheters available including: uncoated polyvinyl chloride (PVC) that needs a separate lubricant for manual application (see Fig. 2.1), gel-coated (pre or self-lubricating) PVC (see Fig. 2.2), and hydrophilic-coated (HC) catheters. HC catheters includes those that require manual activation through addition of water or salt solution or those where the catheter comes ready-to-use, either coated with solution or with solution in a sachet in the package (see Fig. 2.3a) [16]. Catheter selection is dependent on insurance coverage, availability, and patient/caregiver preference. However, catheter type and/or material may be important for patient compliance with IC, which is required if the benefits are to be realized. With a long-term management strategy like IC, patient satisfaction is crucial, as it influences adherence to the IC regimen.



Fig. 2.1 PVC single use catheters that require external lubricant. (a) *Apogee*® Short length straight tip—Courtesy of Hollister. (b) *Apogee*® Long length straight tip—Courtesy of Hollister Inc. (c) Long length with Coudé tapered tip—Courtesy of C.R. Bard, Inc.



Fig. 2.2 Catheter is passed through a self-lubricating reservoir at tip—Courtesy of Hollister Inc.



Fig. 2.4 Male (long) and female and pediatric (short) catheters—Courtesy of Hollister, Inc.

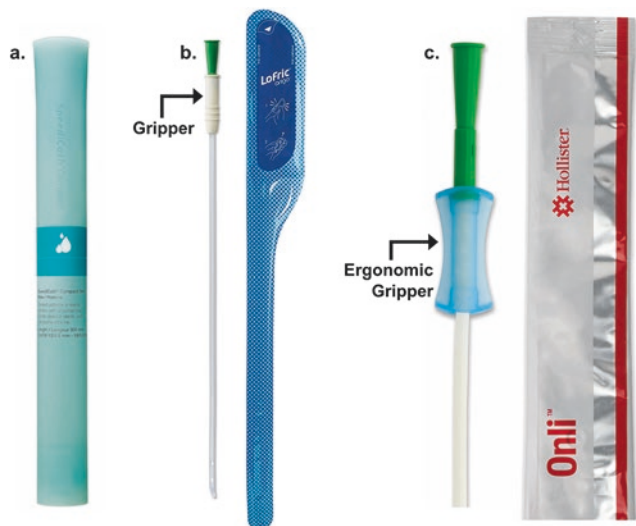


Fig. 2.3 (a–c) Single-use HC catheters (a) Compact “no-touch” design with an integrated bag, also comes in female short length—(*SpeediCath*® CompactSet™)—Courtesy of Coloplast Corp. (b) “No-touch” catheter (12 in., 16 in. length, straight or Coudé tip) with packages, coated with *Urotonic*™ Surface technology, salt solution coating is activated with a gentle squeeze, easily foldable into a small pocket size (*LoFric*® Origo™)—Courtesy of Wellspect HealthCare. (c) Ready to-use HC (16 in.), reduced spill with short (7 in.) and long (16 in.) lengths (*Onli*™)—Courtesy of Hollister Inc.

The characteristics of catheters used intermittently are similar to IUCs (see Chap. 1) and are described below. Types of catheter material are discussed later in this chapter.

Catheter lengths for IC are gender specific, with male, female and pediatric lengths available to accommodate the length of the urethra. Standard male catheter length is 16” (~40 cm), whereas female catheters range in length from 6–12” (see Fig. 2.4). Pediatric catheter lengths are 6–10”. Many women find that shorter catheters do not shift and are easier to grasp and insert (see Fig. 2.5a, b) [1]. The funnel colors of the newer female short catheters may not indicate the size. Catheters are sold individually packaged and some require the addition of lubrication. Catheter lengths can now accommodate more compact designs that are discrete and can be easily carried in a purse or pocket (see Fig. 2.6a–d) [12]. Chartier-Kastler and colleagues [17] reported on a randomized, 2-way crossover, multicenter study in patients with NLUTD ($n = 125$) that evaluated discreet design compact HC catheters compared to standard catheters. The study showed 63% of patients preferred compact HC catheters because of their positive effect on quality of life.

Catheter diameter is measured in French (Fr) units, similar to the size of IUC diameter. Sizes range from 6 to 12 Fr for children and 14 to 22 Fr for adults. The funnel end of the catheter is often color coded to allow for easier size identification (see Fig. 2.7).

Catheter tips are curved and tapered (Coudé/Tiemann/Olive tip) or straight (see Fig. 2.8a, b). They are most often referred to by the generic term Nelaton (after Auguste Nelaton, inventor of the Nelaton rubber catheter) (see Fig. 2.9). This is often the catheter that patients will begin to use during their

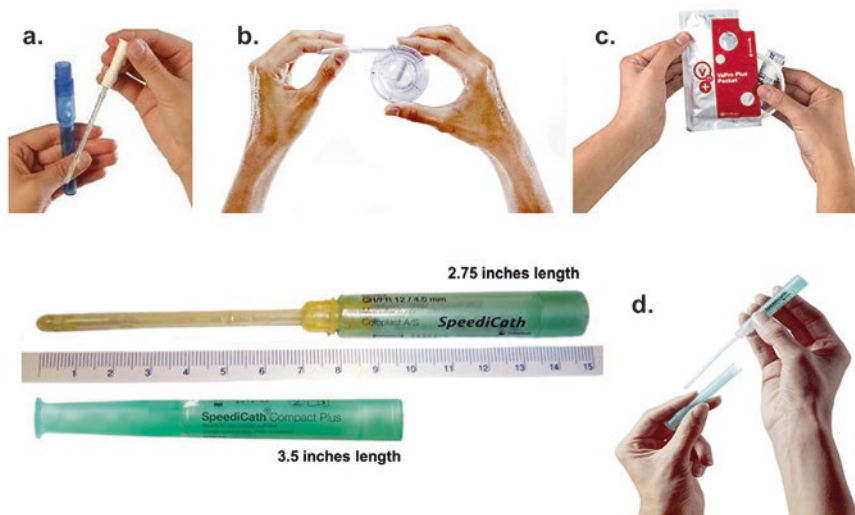
initial transition to IC [18]. A Coudé or Tiemann tip intermittent catheter is firmer and curved at a slight angle to assist in navigating of the male urethra (see Fig. 2.8b). The curve is tapered to the tip. The shape and stiffness of the catheter help to ease the passage through the bladder in patients with an enlarged prostate. Carson and olive tipped catheters (see Fig. 2.10) have a slightly larger bulb at the end that may assist in negotiation of a urethral stricture or to assist female patients in locating the meatus [1].

Catheter drainage openings (“eyes” or “eyelets”) are placed on one side or on opposing sides of the tube (see Fig. 2.11). Opposing drainage eyes generally facilitate better drainage. Some patients have problems with sediment or mucus that can clog the drainage eye and larger openings may be needed. Catheters have been designed with smoother eyelets, either polished or ultrasonically smoothed eyelets to minimize urethral abrasion during passage.



Fig. 2.5 14 Fr Female adult and pediatric short length catheters. (a) HC catheter with straight tip, salt solution sachet and larger funnel end that allows for better grip (LoFric® Sense™)—Courtesy of Wellspect HealthCare. (b) Female catheter with straight tip (Magic® Go)—Courtesy of C.R. Bard, Inc.

Fig. 2.6 (a–d) Small discrete packaged, pocket/compact catheters. (a) Short catheter (Twist®)—Courtesy of Cure Medical. (b) Catheter coiled around a case, “no-touch” as passed through a sheath, coiled back in case when done (Compact Cath). (c) Pocket “no-touch” catheter (VaPro® Plus Pocket)—Courtesy of Hollister Inc. (d) Compact 2.75 in. length female (SpeediCath®) & 3.5 in. length female (SpeediCath® Plus)—Courtesy of Coloplast, Corp.



Although IC has decreased the incidence and severity of UTIs in hospitalized patients, hospital acquired gram-negative organisms in the urine, many of which are resistant to antibiotics have become a major concern. Catheter-associated UTIs (CAUTI) remains the most common hospital acquired infection (HAI) [19]. Such infections result in increased morbidity, loss of patient therapy time, prolonged hospital stays, and increased rehabilitation costs [20]. Healthcare facilities have gone to great lengths to reduce the incidence of CAUTI, driven by denials in reimbursements from insurers.

Introducer tips are preferred by some clinicians for certain patients. Many systems are catheters enclosed in a bag with a urethral introducer tip (see Fig. 2.12) that protects the catheter from contamination as it passes through the first 1.5 cm of the urethra, where larger numbers of micro-organisms are present [21, 22]. This portion of the distal urethra can be colonized with perineal bacteria, particularly *E. coli*. Colonization with other pathogens, such as *Pseudomonas* and *Klebsiella* species, frequently occurs in the perineum and urethra of men with a SCI (see Fig. 2.13a–c Introducer tips instructions).

The MMG/O’Neil catheter (Medical Marketing Group) was the first example of an intermittent catheter system with an introducer tip (see Fig. 2.14). It was originally developed in Australia in 1982 for use in obstetric patients, but has been tested in acute and rehabilitation settings on SCI patients. Other manufacturers have incorporated introducer tips in their products.

Catheter Reuse

Reuse of catheters for IC is controversial. Manufacturer guidelines state that a catheter designed for intermittent drainage of the bladder is single-use and is to be discarded



Fig. 2.7 Catheter funnels: color-coded French (Fr) size—Courtesy of Hollister Inc.

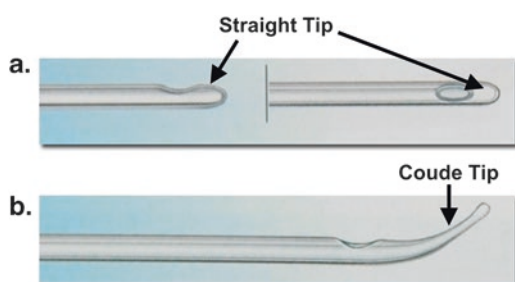


Fig. 2.8 Catheter Tip configurations (a) Straight tip (b) Coude tapered tip

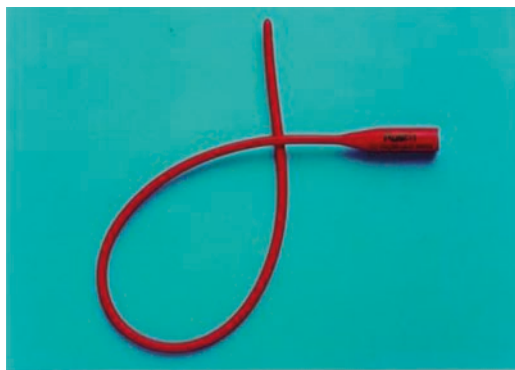


Fig. 2.9 Nelaton red rubber catheter—Courtesy of C.R. Bard, Inc.



Fig. 2.10 Olive Coudé Tip with eyelets repositioned to the sides of the catheter and a blue Guide Stripe® along the top of the catheter allows the patient to monitor correct position of the Coudé tip throughout catheterization (*Self-Cath® Plus*)—Courtesy of Coloplast Corp.

after use. According to the US FDA, all sterile urethral catheters are single-use devices and not approved for reuse. Many patients and providers argue that there is a theoretical increased infection risk if a catheter is reused. Despite the wide use of IC, two Cochrane reviews [23, 24] noted that



Fig. 2.11 Offset eyelets on catheter tip



Fig. 2.12 Gel-based catheter with introducer tip (Advance Plus)—Courtesy of Hollister Inc.

there are no definitive studies showing improvements in the incidence of UTI by catheterization technique, type, or strategy. Data are also lacking for recommending a cleaning method for multiple-use catheters. However, one of these reviews has recently been withdrawn [24] and their findings have been questioned [<http://online.liebertpub.com/doi/pdf-plus/10.1089/neu.2017.5413>]. The most recent guidance from Infectious Disease Society of America also rated the evidence for multiple-use as poor [25].

Moore et al. [26] found that 87% of patients (62/71) cited concerns over infection as the main reason for refusal to reuse catheters. Since 2008, single-use, disposable catheters for ISC has become the standard in the US as health insurers and providers, including Medicare and the VA system have changed reimbursement to allow the purchase of single-use catheters. Medicare, now allows purchases of up to 200 catheters per month [2].

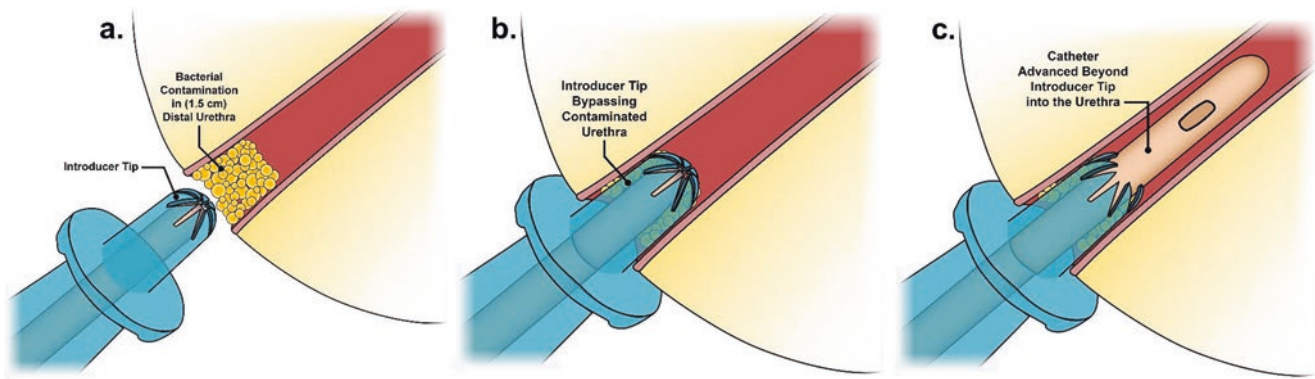


Fig. 2.13 (a–c) To bypass the distal urethra area, the catheter is advanced into the introducer tip, the tip is inserted into the distal urethra, and then the catheter is passed through the tip into the urethra. This prevents contamination of the catheter and introduction of bacteria into the bladder



Fig. 2.14 Original introducer tip closed “No touch” catheter system—Rusch MMG

This is also the case in other countries but reuse after cleansing may be the only option in certain circumstances (e.g., lower income countries) [27]. Health care providers should advocate a single use of catheters in individuals with SCI, especially as there is no standardized or universally accepted cleaning method [<http://online.liebertpub.com/doi/>

[pdfplus/10.1089/neu.2017.5413](https://doi.org/10.1089/neu.2017.5413)]. If UTIs become problematic in an individual reusing a catheter, he/she should be encouraged to use a new catheter each time.

In patients on IC, bacteriuria is more likely caused by ascending bacteria into the bladder colonizing the urethra, than introduction of new bacteria [14, 25]. Rinsing with water, microwaving, boiling or soaking catheters in various agents and then air-drying are all thought to be effective in reducing bacteria on catheters. However, there are no published trials evaluating the effectiveness of any of these cleaning-methods in preventing bacteriuria or CAUTI [28]. Many experts discourage microwaving and boiling catheters as increased temperatures may alter properties of the catheter.

Closed vs. Open System Catheters

Currently, no high-level evidence demonstrates sterile technique as superior to clean technique for reducing CAUTI. Likewise, no evidence has demonstrated closed or pre-packaged catheter kits containing all accessories (e.g. gloves, –antiseptic, –solution, etc.) (see Fig. 2.15) to be superior to closed self-contained (catheter in the collection bag, tip pre-lubricated) catheter systems (some are referred to as “no-touch” or “touchless”) (see Fig. 2.16). Both systems are sterile. Use of the “no-touch” technique (in which the catheter and pre-attached collecting system are not touched by the patient) reduces microbial contamination of the catheter (see Chart 2.1) [22]. There is some evidence that use of sterile prepackaged catheter collection kits can reduce the frequency of UTIs in SCI patients [27, 29]. However, these kits are expensive and insurers require justification for them. At least two CAUTIs in a patient in 12 months would be medical justification for prescribing a sterile catheter kit or closed system [30]. These kits are also justified if the patient is immunosuppressed (e.g. post-transplant), has AIDS, on cancer chemotherapy, documented vesicoureteral reflux and/or resides in a nursing facility.



Fig. 2.15 (a–d) Sterile IC kits with gloves, antiseptic cleanser, lubricant, introducer tip, catheter in drainage bag. (a) *Advance Plus*—Courtesy of Hollister Inc. (b) *Touchless® Plus* catheter kit—Courtesy

of C.R. Bard Inc. (c) *Self-Cath* with introducer tip—Courtesy of Coloplast, Corp. (d) *Cure Catheter™ Closed System*—Courtesy of Cure Medical

Fig. 2.16 *Touchless® Plus* Catheter system—Courtesy of C.R. Bard, Inc.

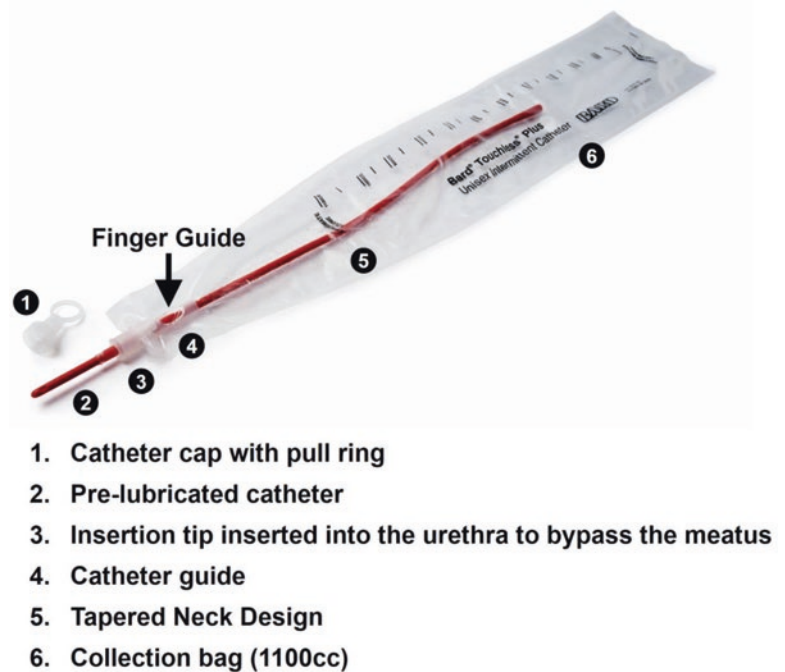
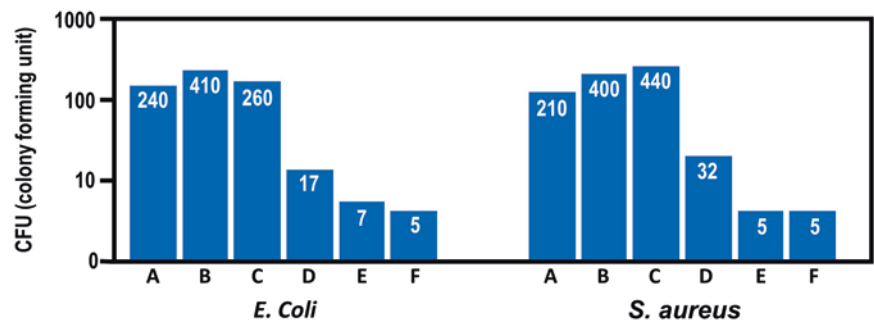


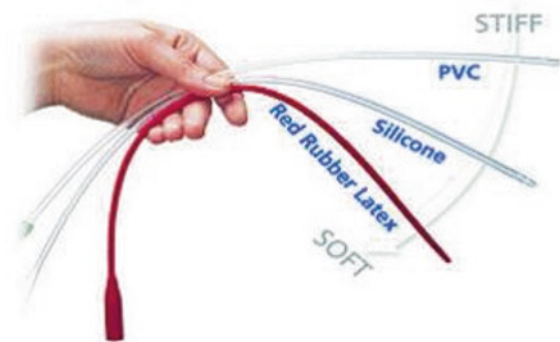
Chart 2.1 “No-Touch”

method: reducing bacteria.

Catheter A: EasiCath (Coloplast, Humlebaek, Denmark), *Catheter B:* SpeediCath (Coloplast, Humlebaek, Denmark), *Catheter C:* LoFric® (Astra Tech, Mölndal, Sweden), *Catheter D:* LoFric® H2O (Astra Tech, Mölndal, Sweden), *Catheter E:* Hollister Advance Intermittent Catheter (Hollister, Illinois, US), *Catheter F:* VIALOG Mobile (Medical Service, Bad Liebenzell, Germany). Adapted from Hudson and Murahata [22]



Catheter A – EasiCath (Coloplast, Denmark)
Catheter B – SpeediCath (Coloplast, Denmark)
Catheter C – LoFric (Wellspect, Sweden)
Catheter D – LoFric H2O (Wellspect, Sweden) (no longer available)
Catheter E – Hollister Advance Intermittent Catheter (Hollister, USA)
Catheter F – VIALOG Mobile (Medical Service, Germany)

**Fig. 2.17** Different catheter material

Materials

Catheter surface material and properties can be important when it comes to UTIs, urethral complications, and patient satisfaction and preference. A number of different polymers are used for the construction of catheters, including PVC, rubber, nylon, and silicone (see Fig. 2.17). PVC is the most common as it is inert and does not react when it comes in contact with bodily fluids. The Nelaton, Coudé/Tiemann, and O’Neil catheters can be made of different types of materials which include red rubber latex, PVC or other plastics, or silicone. One concern with the manufacturing of flexible PVC devices is that plasticizers, such as di-2-ethylhexylphthalate (DEHP), must be added. PVC and DEHP both implicate environmental and health concerns, so alternative materials have been developed. PVC-free catheters are available including polyolefin-based elastomer (POBE), such as the *LoFric*® catheter, used since 2008 [31], and polyurethane tube material of *SpeediCath*®. Catheters made of POBE have lower environmental impact [32]. Although more expensive, silicone catheters have increased in popularity due to

increased latex allergies. However, unlike the silicone material used for IUCs, silicone catheters manufactured for intermittent use are softer and more flexible. Some persons may have trouble advancing the softer silicone catheters, while stiffer catheters (e.g. PVC) may cause urethral trauma. One new composite catheter design has three layers, with a soft outer silicone, a stiffer silicone middle layer, and an inner, pliable silicone layer (see Fig. 2.18 M³ Technology). The design is also available with both hydrophilic and antimicrobial coatings.

Designs

Coated and non-coated are two main designs of catheters used for intermittent bladder drainage. Some catheters are sterile, individually packaged and intended for one-time use (see Fig. 2.19 Individually packaged PVC). But some uncoated catheters, primarily PVC catheters, have been reused, when insurance coverage is not available and cost is a factor [34]. Noncoated catheters require separate external gel lubrication, before insertion. Catheters with a coating and flexibility are self-lubricated and thus are designed to improve catheter lubrication and ease of insertion and, may reduce trauma and UTIs. The most common coating is hydrophilic [35].

Antimicrobial coated catheters: Intermittent catheters, like IUCs, may also be coated with antimicrobial agents. Nitrofurazone and silver are the two most commonly used.

Hydrophilic coated (HC) catheters have become increasingly popular. They were introduced in 1983 to reduce catheter-related complications and have demonstrated the potential to decrease UTIs in persons who use IC for bladder management [36]. HC catheters (discussed later) have a polymer coating that adheres to the catheter surface and becomes slippery and smooth when wet. They were developed with the goal of reducing friction, thereby reducing trauma during

Fig. 2.18 *Magic*^{3®} Technology- 3-all silicone layer—Courtesy of C.R. Bard, Inc.

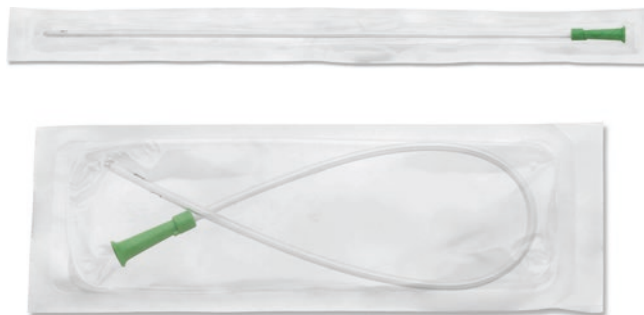
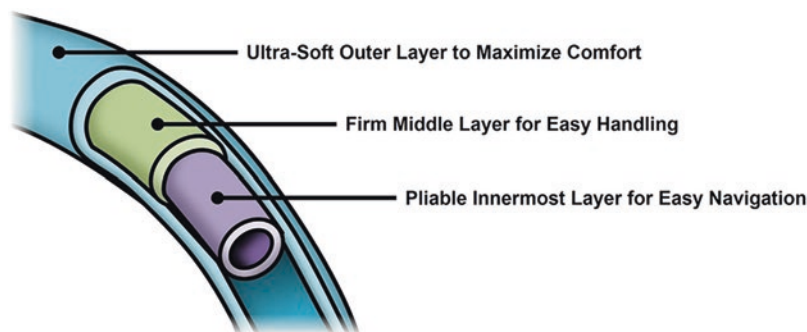


Fig. 2.19 Individually packaged 14Fr PVC non-lubricated single-use Apogee catheter—Courtesy of Hollister Inc.

the catheterization process. HC catheters include those that require the addition of water by breaking or bursting a water packet or salt solution in the packaging which activates the hydrophilic coating (see Fig. 2.20a–c). Prehydrated and ready-to-use HC catheters also exist. Both types of HC catheters remain strictly for one-time use and should never be reused. The lubrication helps to ensure more comfortable insertion and decrease friction and trauma to the urethra. Hydrophilic catheters (see Figs. 2.21 and 2.22) contain a coating made of polyvinylpyrrolidone (PVP), which is a non-allergic material that has been used in medical devices since the 1930s. When exposed to water, the PVP coating attracts water to the surface of the catheters, creating a biocompatible coating that binds water to the surface of the catheter and forms an outer layer mainly consisting of water. This thick, slippery, smooth layer of water stays on the catheter, ensuring lubrication of the entire urethra during the catheter insertion and withdrawal, thereby reducing the coefficient of friction by at least 95%. A recent study compared PVC versus a PVC-free material (POBE) catheter (e.g. *LoFric*[®]) [37]. Low rates of discomfort were found with both, but the PVC-free HC catheters had fewer instances of discomfort.

A “touchless” catheter is a one-time use catheter that is either enclosed in a collection bag (see Figs. 2.14, 2.15, 2.16, and 2.20), has a protective sleeve that covers the catheter preventing direct hand contact with the catheter during preparation and catheterization [38] (see Fig. 2.23), or has an insertion aid (gripper) (see Fig. 2.3b, c). This type of catheter is recom-

mended for patients with a history of frequent CAUTIs (e.g. secondary to poor technique). Many use this product when away from home. Although more expensive, these products are generally covered by Medicare and private insurance, if justification and medical necessity is provided.

Gel coated IC kits contain a water soluble gel reservoir or chamber, which provides lubrication as the catheter passes through the gel chamber at the tip of the catheter. This helps to prevent contamination; as direct contact is not needed to apply the lubricant. A disadvantage of these catheters is that they can be slippery and messy, making it difficult for the patient to hold the catheter during insertion.

Noncoated catheters are generally packaged with a separate gel, usually in a foil packet that must be opened and applied directly to the catheter prior to insertion. This requires an extra step, can be messy, and can be difficult to ensure complete lubrication of the entire catheter. Some female patients use only water to lubricate the catheter.

Evidence-Based Research

Hydrophilic coated catheters have been developed with the goal of reducing friction and thereby reducing trauma during the catheterization process. Chartier-Kastler and Denys [39] published a review of experimental and observational evidence, including randomized controlled trials that noted a large body of evidence to support the benefits of HC catheters in patients with NLUTD [10]. This data indicates that HC catheters may be preferable to PVC catheters in terms of safety and quality of life. Most of the research on IC has focused on the *LoFric*[®] and *SpeediCath*[®], and as compared with PVC catheters, include reduced UTIs [10, 40, 41], reduced micro-hematuria [41, 42], and high levels of patient satisfaction [40, 41]. De Ridder and colleagues [40] found, in a randomized 1-year prospective trial in 2005, a statistically significant reduction in UTIs with hydrophilic coated versus noncoated catheters. However, 64% of persons using HC catheters (versus 82% for noncoated catheters) still had one or more UTIs during the study period. Furthermore, there was no significant difference in bleeding, bacteriuria, or pyuria between the two groups. Stensballe et al. [43] found a

Fig. 2.20 All-in one catheter system with water and an integrated urine collection bag, useful for wheelchair users or bedridden patients.

(a) Foldable into discreet pocket size, (b) Catheter with Urotonic™ Surface Technology activated with salt solution sachet, integrated bag attached, (c) Fold and press to activate sterile salt solution sachet. Available in sizes for men, women, and children, straight or Coudé tip. (LoFric® *Hydro-Kit*™)—Courtesy of Wellspect HealthCare

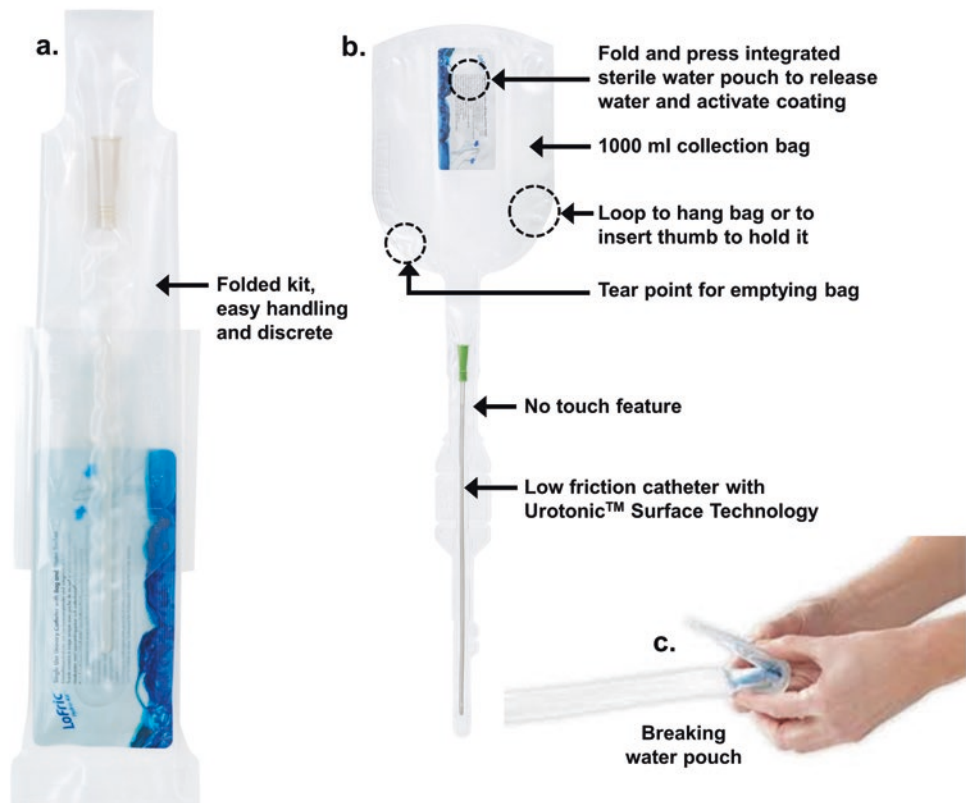
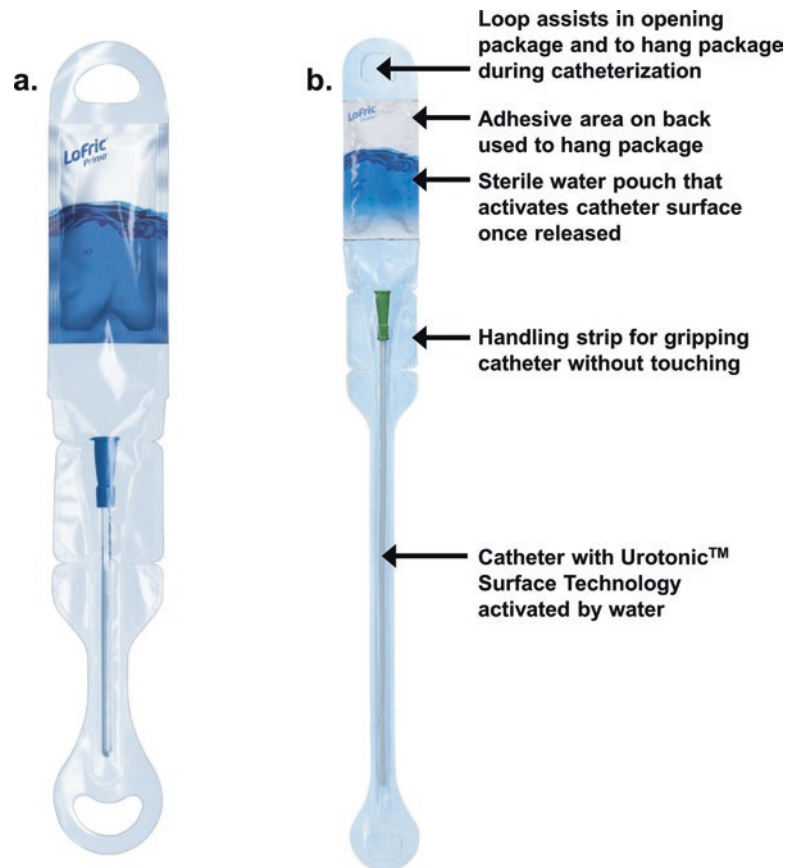


Fig. 2.21 HC catheter packaged with sterile water, once released, activates catheter coating. Ability to place close to patient with adhesive attachment. Available in sizes for men, women, and children, straight or Coudé tip. (LoFric® *Primo*™)—Courtesy of Wellspect HealthCare



reduction in hematuria, pain, and higher patient preference, for HC catheters. One study found no difference in the number of symptomatic UTIs versus noncoated catheters [10]. However, a study by the same group [44] found that the use of a HC catheter reduced the risk of UTI in the acute period and significantly delayed the time to first UTI for HC versus

a plastic uncoated catheter. A systematic review of RCTs that compared HC catheters and PVC catheters was performed by Rognoni and Tarricone [45]. The authors conducted a separate data analysis to combine data on frequencies of UTIs and hematuria. The separate analyses took into account reused standard catheters. The results showed that HC catheters were associated with reduced risk of UTIs. These authors considered both single-use and single-use plus reused catheter scenarios. HC catheters with high osmolality (e.g., LoFric®) seemed to lower the risk of hematuria. HC catheters may also be useful for persons with urethral strictures or discomfort during catheterization [28].

HC catheter with lower osmolality however, have the disadvantages of varying surface drying times and some become “sticky” when dry. Also, the design of these catheters varies in terms of material, length, and flexibility, and there is no research comparing the different products.

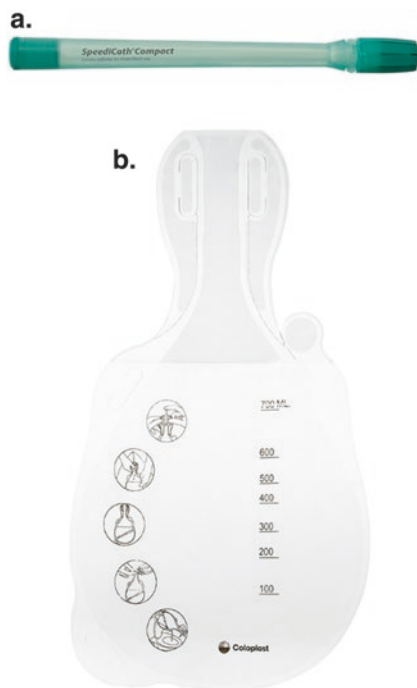


Fig. 2.22 HC catheter 12/18 Fr with separate drainage bag for males or females—(*SpeediCath*® Compact Male with *SpeediBag*® (optional)—Courtesy of Coloplast Corp.

Special Features and Devices for IC

Assistive devices have specific features that may facilitate a patient in successful self-catheterization. They include mirrors, catheter holders, and devices to aid in meatal location (see Fig. 2.24). Some IC kits have features to facilitate IC by persons with impaired hand function (e.g., persons with quadriplegia). For example, some kits have loop holes or an adhesive tab to allow the kit to be hung on the wheelchair or on a wall (see Fig. 2.25), or to insert a thumb for easy opening (see Figs. 2.20b and 2.23a). A physician with tetraplegia developed a device to hold the penis in place during catheter-

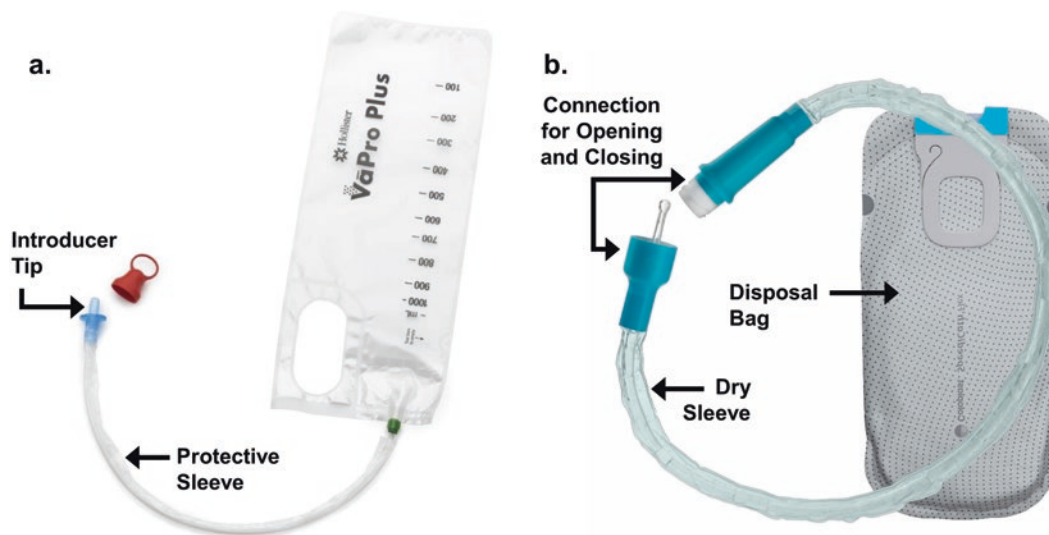
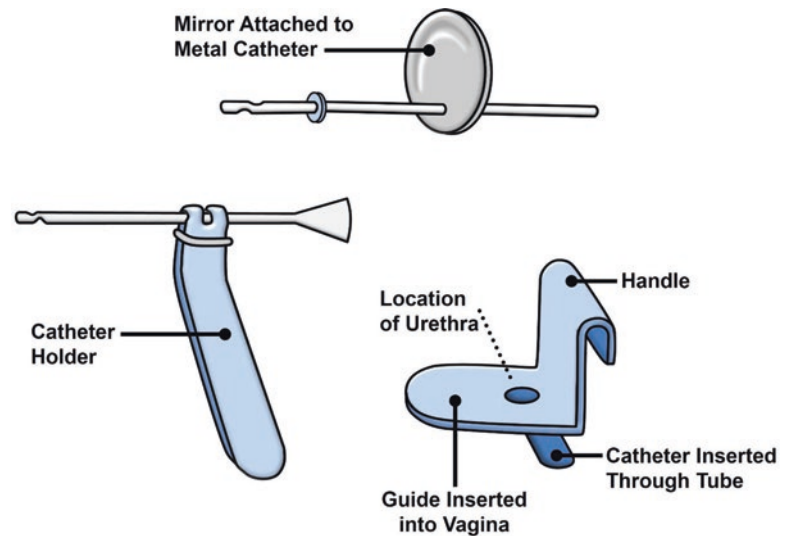


Fig. 2.23 Touch-free HC catheter with protective sleeve and protective tip to protect catheter from contamination. Protective sleeve is pulled back while catheter is inserted. Drainage bag attached. Comes in standard and pocket size. (a) Straight and Coudé tip available (*VaPro*™

Plus)—Courtesy of Hollister Inc. (b) Flexible tip that easily bends during insertion, water coats catheter and should be drained prior to insertion. (*SpeediCath*® Flex Coudé)—Courtesy of Coloplast Corp.

Fig. 2.24 Assistive devices for IC**Fig. 2.25** Adhesive on package allows catheter to be attached to wall for easy reach during catheterization

ization (see Fig. 2.26 House Hold) [46]. The PerfICath (see Fig. 2.27) single-use catheter kit was also developed by the same physician. The sleeve is designed to be placed between the fingers and the catheter is advanced with the sleeve, not requiring the use of a finger grip. It is designed to allow the catheter to be pulled back into the sheath after use. It contains a gel reservoir, introducer tip, and two drainage ports for either fast or slow drainage. A hydrophilic version is being developed. Other catheter manufacturers have developed devices to facilitate gripping slippery HC catheters (see Fig. 2.28 U-Cuff Universal cuff or Fig. 2.29 LoFric® gripper tool) or other catheters. Devices exist that either hold the

**Fig. 2.26** Household Penis Collar—(www.icancath.com) holds penis in place, is reusable, and lasts approximately 2 years with daily use. It can be cleaned with soap and water [46]

catheter steady for insertion (see Fig. 2.30) or spread the female labia to ease insertion (see Fig. 2.31).

Other IC kits have special features to facilitate advancing a catheter with use of gross, rather than fine grasp (see Fig. 2.32 Gripper catheter). Mike Ritmiller, a physician assistant who specializes in urology, developed a device that is designed to lie on the man's legs, to serve as a platform to hold and advance an IC closed system (see Fig. 2.33).

Urine Collection Devices/Urinals for Use With Intermittent Catheterization

Many persons who perform IC use external or “condom” catheters to collect urine in between catheterizations. These are discussed in Chap. 3. Persons who use individual catheters not in kits may empty their urine into a variety of receptacles, including typical hard plastic urinals. However,

Fig. 2.27 PerfIC Cath
(www.adaptamedical.com)

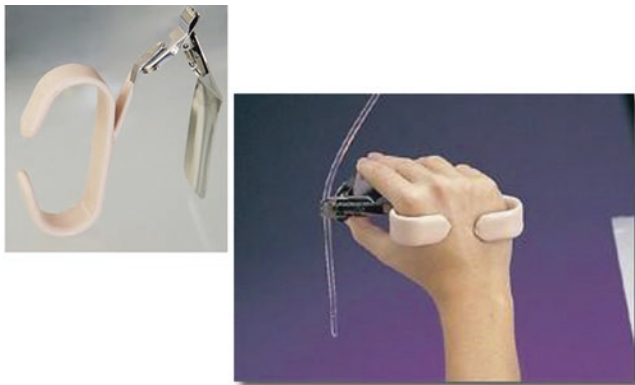


Fig. 2.28 U-Cuff—Universal cuff for limited hand function

these receptacles are often bulky and not well suited to carrying. The Uribag® (see Fig. 2.34 Uribag® 2 views) was designed for use by campers and is not marketed as a medical device. It consists of a flexible rubber bag attached to a hard plastic tube, with a cover that can be closed, allowing urine to be stored if necessary for later emptying in a suitable location. If the bag is pushed into the sleeve, it is compact and unobtrusive and looks like a large roll of camera film. Both male and female versions exist (see Chap. 7).

Promoting Patient Adherence To Intermittent Self-Catheterization

The health care provider and the patient must adhere to IC recommendations. Adherence to the prescribed IC frequency is important as it can directly impact the function of both the lower and upper urinary tracts, and may influence UTI risk [47]. According to Drake et al. [3], no guidelines

or consensus exist on suitable intervals for bladder emptying. Ideally, catheterization frequency should be based on a diary (see Table 2.2), which records fluid intake, voided and catheterization volumes. If the patient is voiding and performing IC, recording and monitoring both volumes would assist with determining returning bladder function, and catheterization adherence. Additionally, PVR, and urodynamic parameters should be assessed, if available (detrusor pressure, bladder compliance) [16]. Inadequate catheterization frequency and elevated PVRs will lead to UTIs [16]. The largest catheterization volumes may occur in the morning, especially in older adults and those with edema. These persons should consider performing catheterization right before going to bed.

There are, however, barriers that patients face when self-catheterizing that may ultimately limit adherence. There are only a few studies examining adherence to IC [47]. Chai et al. [48] examined adherence rates to IC in SCI patients and reported that 71% were still using IC after a mean of 5.9 years. No studies were found that examined adherence in samples that included non-SCI individuals or that compared self-reported catheterization frequency to that prescribed by health care providers [49].

Both internal and external factors may pose as barriers to successful IC. Internal, patient-related factors include physical or psychological barriers. Physical barriers refer to the practical factors that hinder catheterization and psychological barriers refer to the psychosocial and cultural aspects that may restrict its use. External factors involve the quality of the IC teaching, supervision, follow-up, and catheter availability in the community.

In a study by Seth and colleagues [6], the most commonly reported barrier was lack of access to a public toilet (34%). Other barriers included difficulty positioning to insert the

Fig. 2.29 (a) Catheter tool at catheter tip. (b) Catheter tool at catheter funnel end. (LoFric® EZ-Grip Tool)—Courtesy of Wellspect HealthCare

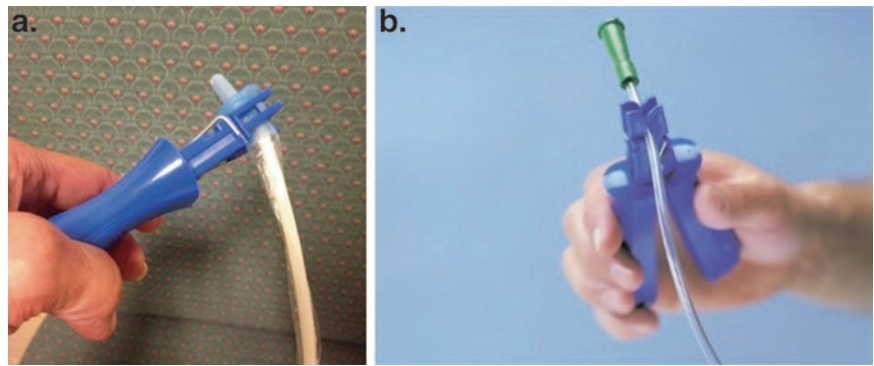


Fig. 2.30 P hold—Courtesy of Manfred Sauer

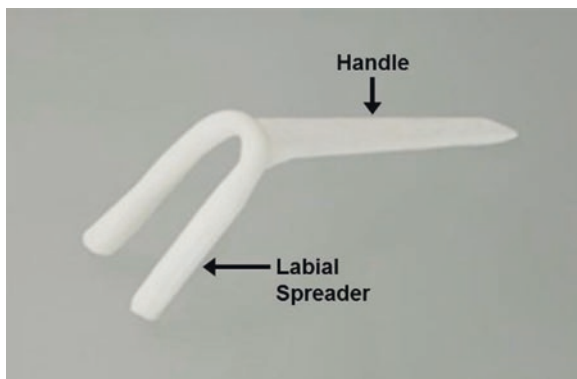


Fig. 2.31 Labial spreader—Courtesy of Manfred Sauer

catheter (25%) and problems with dexterity (21%), especially in patients with multiple sclerosis (MS). Cost of supplies was also a barrier (18%). Only half of the patients claimed to be completely satisfied with IC, 40.9% were somewhat satisfied, and 9.1% were not satisfied [6].

Dexterity was reported as a common barrier to IC, due to spasticity, which often affects patients with neurological problems such as MS and those with SCI [49]. In a study by Zlatev et al. [50], 23.3% of patients with an SCI lacked upper



Fig. 2.32 Gripper catheter—Courtesy of Coloplast Corp.

extremity function to self-catheterize. Up to 50% of patients abandon use of IC within 5 years [51]. These authors suggested that IC 'dropout' may be due, in part, to a patient's physical inability to independently perform IC. To assess if hand dexterity or upper extremity strength are barriers, consider the use of a tool, such as the Pencil and Paper test described by Amarenco et al. [52]. This test employs a series of simple tasks using a pencil and paper that mimics the ability to open the packaging and handle a catheter, as well as the cognitive strategies required.

Anatomical barriers that can potentially reduce the success and ease of IC are obstructions to the outflow of urine from the bladder and are usually either due to an enlarged prostate or to urethral stricture disease [6]. In these cases, a Coudé tip or olive tip catheter should be recommended.

Relevant cognitive domains required to perform self-catheterization include comprehension, attention, memory, and motor planning, and therefore, the assessment of the patient should include a brief assessment of these domains. Motor

Fig. 2.33 Eagle board is a patented assistive device to allow patient with limited dexterity to self-catheterize. (a) Different components of Eagle board. (b) Eagle board with catheter in place— Courtesy of Medical Technology of Georgia (MTG)

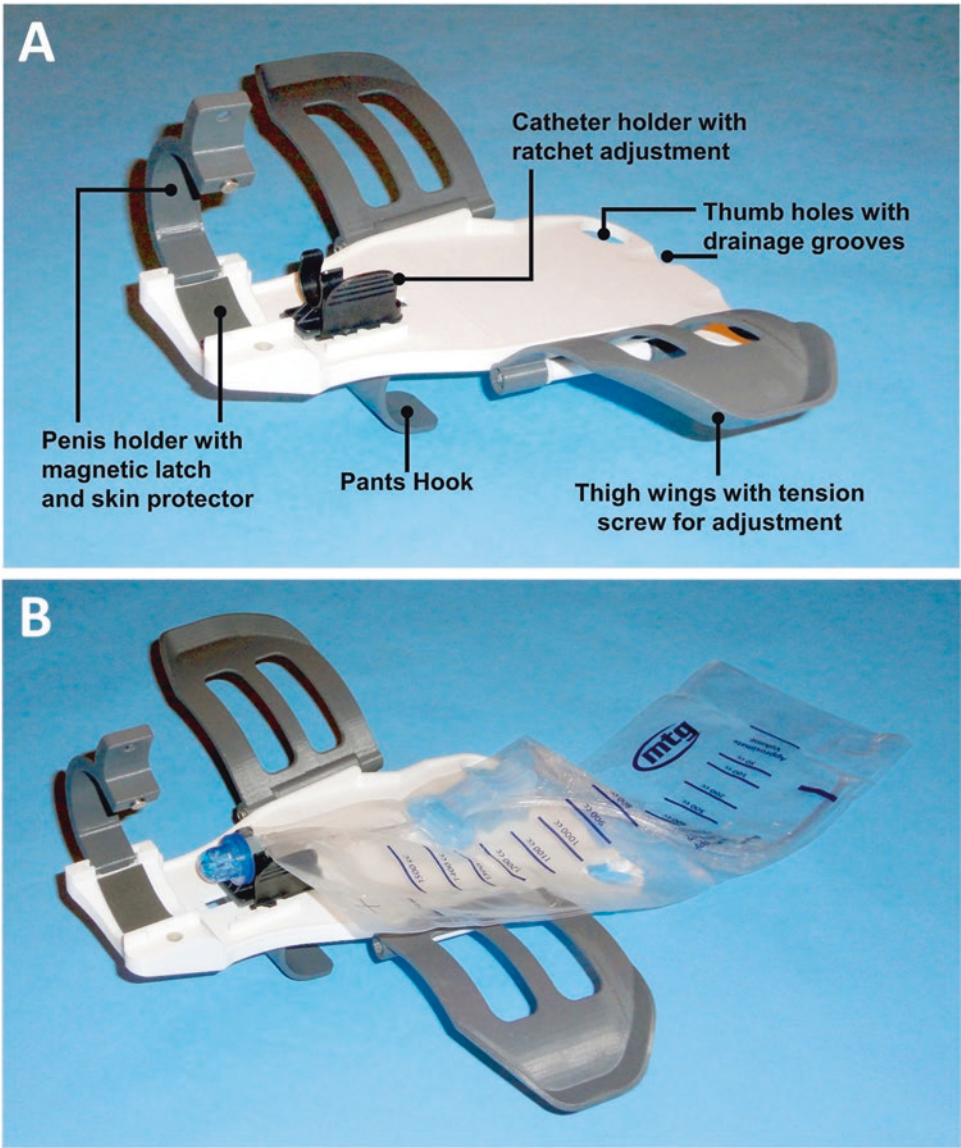


Fig. 2.34 Uribag® – available in male and female sizes - Kinsman Enterprises, Inc. in the US

Table 2.2 Catheterization diary

Date	Time	Voided volume	Catheterization amount	Fluid intake	Comments
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—

Record in ounces or millimeters the date, time, and amount you urinate (void) and/or catheterize and the amount of fluid intake

planning includes the ability to conceive, plan, and carry out a skilled, non-habitual *motor* act in the correct sequence from beginning to end. Incoming sensory stimuli must be correctly integrated in order to form the basis for appropriate, coordinated *motor* responses. For successful IC, the individual should be aware of the need to catheterize and respond

accordingly. Memory of the technique is also paramount, including the correct sequence of steps for the procedure, as well as measures to ensure hygiene. One study in both young and older adults found determinants of adherence related to lack of knowledge, complexity of the technique, misconceptions, –fears, shame, motivation, quality, and continuity of professional care. In younger persons, availability of materials, physical impairments and resistance to a sickness role could further reduce adherence [53]. Patient education should include exploring patient fears and misconceptions of the risks of IC. Patients also cite the inability to access the right type of catheter as a reason for discontinuing IC [54]. Catheter size, type, and material influence catheterization comfort. It is crucial, therefore, that the patient selects a catheter with which they are competent and comfortable using [6].

Many factors may affect patient adherence to successful IC. When patients are discharged home with IC, it is important to identify what barriers may affect their adherence. Patients need ongoing professional support to help ensure that they have access to the education, correct supplies, resources and followup.

Complications

IC is a common procedure, but is not without complications. Annual follow-up is needed to prevent and/or determine complications. A repeat bladder evaluation including renal (upper tract monitoring), bladder and/or urodynamic function has been recommended [3]. The following are the most common complications seen with IC. Their prevalence increases in long-term IC patients.

Urinary tract infection: Incidence of *asymptomatic* bacteriuria is as high as 60% in IC users, but patients may develop resistance to organisms if they are treated inappropriately with antibiotics. UTIs remain the most frequent type of infection in persons with SCI&D, with an average of 2.5 episodes per year [30]. Before World War II, urinary tract complications were considered to be the number one cause of death in the acute period after SCI. However, advances in urologic diagnosis and management through the use of urodynamic assessments and IC have reduced acute deaths and complications, improving the urinary tract–related quality of life for persons with SCI&D. Despite these advances, morbidity from UTIs remains common. In this regard, optimal urinary tract management is critical not only for the prevention of complications and illnesses, but also for the optimal social integration of the person with SCI&D.

There are certain populations who may be at greater risk for CAUTIs. Myelomeningocele patients may have NLUTD that predisposes them to UTIs, and such infections can have detrimental effects on their already compromised urinary tract. End-stage renal disease occurs in 15% of myelomeningocele patients and the mean age for transplantation in this

patient population is 27 years. One of the first lines of management to guard against renal damage in selected patients is the implementation of IC. The choice of catheter (e.g., HC catheter) may decrease CAUTI risk in this population [55].

Frequency of IC, bladder overdistension, female gender, non-hydrophilic coated catheters, behavioral/hygiene factors, and poor education have all been found to increase the risk of a CAUTI [40, 56]. Table 2.3 lists possible causes of CAUTIs. A recent review reported low rates of complications or infections with IC when compared to IUC [13].

Urethral injury: Repeated catheterization has the potential to cause mechanical injury to the urethra, resulting in hematuria urethritis, cystitis, stricture, and other complications such as false passage [58]. To reduce urethral trauma, generous lubrication of the catheter is recommended. Prostatic irritation and prostatitis, epididymitis, and orchitis can occur in persons performing IC. Urethral strictures are seen more often in patients using latex catheters. This is felt to be related to cellular toxicity due to elutes from rubber causing urethral erosion over time, particularly in males [58]. These strictures can occur either in the anterior (meatus, penile-pendulous urethra, bulbar urethra) or in the posterior portion (membranous urethra and prostatic urethra) of the urethra.

Difficulty with catheter insertion can be a sign of the presence of a urethral stricture. It is felt that the higher the frequency of catheterization, the less the urethral changes. This might be due to the fact that those individuals regularly performing IC develop more skill in catheterization and therefore, have less chance of urethral trauma. False passage may be caused by infection and inflammation of periurethral tissue. De Ridder et al. [40] noted catheter-induced hematuria and leukocyturia secondary to repeated trauma, which contributed to the development of UTIs. They also reported a lower rate of UTIs among HC catheter users, but did not find a significant difference in pyuria, hematuria, or bacteriuria between the two groups. Sarica et al. [35] found decreased urethral trauma and microhematuria with either hydrophilic or gel lubricated coated catheters compared to PVC catheters. Other complications can occur. For example, upper urinary tract damage can occur if management is not optimized. Newman and Willson outlined potential complications related to IC in detail [1].

Scrotal complications: Epididymitis has been reported in 10–29% of patients who perform IC using PVC catheters [59] and in 6% of patients using low-friction HC catheters. This infection appears to be more common in men who develop a urethral stricture. Men may also experience prostatitis.

Bladder-related complications: Hematuria is frequently seen during the initiation of IC, but should not be a persisting problem. New-onset hematuria may indicate a UTI or stricture or a number of other conditions, including malignancy. Bladder stones caused by the introduction of pubic hair or loss of the catheter in the bladder, can occur in patients

Table 2.3 Causes of CAUTIs

Cause	Reason	Solution
Inadequate catheterization frequency	Can lead to bladder overdistension, increased intravesical pressure with long periods of urine stagnation increasing the risk of UTI	Catheterizing on a regular schedule will keep the bladder empty and eliminate urine stasis
Incomplete bladder emptying when catheterizing	Residual volume left in the bladder after catheterization provides environment for bacteria proliferation	To ensure adequate emptying, patients should perform a gentle Credé maneuver as the catheter is removed
Inadequate fluid intake	Companion problem to inadequate frequency of emptying. When low urine volumes are produced (<1200 mL of urine per day), patients are less inclined to empty at desired intervals, producing urine stagnation and bladder overdistention	Total daily fluid intake (from foods and all types of beverages) is approximately 2.7 L/day for women and 3.7 L/day for men Most adults adequately meet their daily hydration needs by letting “thirst be your guide”
Poor catheterization technique, and catheter care	Inadvertent introduction of bacteria into the bladder. Increased risk of urethral trauma	Consider re-evaluation of catheterization technique of the person performing catheterization Consider a HC catheter to prevent urethral trauma Consider using a catheter gripper to minimize contamination Consider use of a catheter with an introducer tip to prevent introduction of bacteria at the distal end of the urethra
Excessive fluid intake	If the person cannot or will not adjust fluid intake appropriately for the IC schedule, he/she risks periodic or regular bladder overdistention, and possible overflow UI Excessive intake could produce bladder volumes >500 mL at one time or would be evidenced by the need to catheterize more than 6 times a day	Encourage regular fluid intake, small amounts spaced hourly between breakfast and the evening meal and reducing to sips thereafter
Nocturnal polyuria	Some patients (e.g., those with SCI&D, MS and older adult patients) may have nocturnal polyuria related to inadequate antidiuretic hormone secretion at night or impaired cardiac condition	Large fluid intake in the evening (after 7 PM) should be discouraged Catheterize prior to bedtime and during the night as needed Consider a trial of desmopressin administration at bedtime with careful monitoring of serum sodium levels and cardiopulmonary fluid status or edema
Traumatic catheterization	Breaks in the bladder urothelium and urethral lining increase the risk of infection Difficulty passing the catheter may lead the person to avoid performing catheterization	Assessment of catheterization technique to help correct faulty insertion technique Consider an alternative catheter design (Coudé-tip, hydrophilic coated) to ease passage

Adapted from Newman and Wein [57]

performing long-term IC. There have been anecdotal reports of short-length catheters with a smooth, soft funnel end being inserted and “lost” in the bladder. The literature reports only a few cases of squamous cell cancer of the bladder in patients performing IC [60].

Risk Factors for Development of UTI in Persons on IC

Causes of intermittent catheter-related UTIs, include inadequate frequency of emptying, inadequate emptying at the time of catheterization, inadequate fluid intake, poor cath-

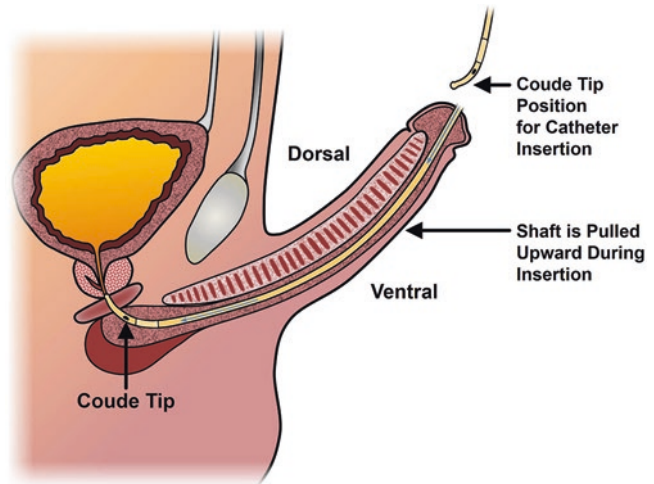
eterization technique, poor catheter care, excessive fluid intake or nocturnal polyuria (leading to bladder overdistension), and traumatic catheterization. Catheterizing less than 3 times per day and mean catheterization volumes over 400 ml are associated with occurrence of UTI [1].

Prevention of Catheter-Associated UTI (CAUTI)

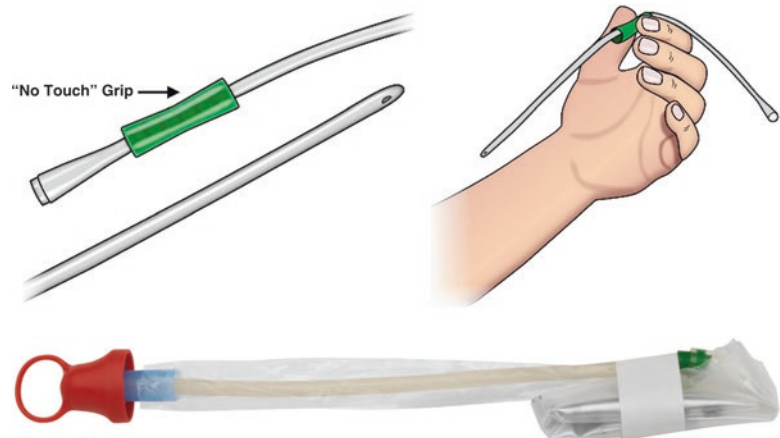
Table 2.4 provides a list of Best Practices for the Prevention of CAUTIs.

Table 2.4 Best practices for prevention of CAUTIs

1. Education and teaching are necessary to prevent any IC-related complications
2. Maintenance of hygiene, particularly of the hands and perineum
 - Hands should be thoroughly washed before attempting catheterization
 - The genitalia should be washed daily with soap and water and always cleansed from front to back
 - It is preferable to perform catheterization before a bowel program to minimize fecal bacteria contamination of the urethra
 - Immediate perineal hygiene is recommended after vaginal intercourse as the act of intercourse may push fecal bacteria into the urethra.Avoid spermicidal lubricants in sexually active females as these products may alter normal vaginal and lower urethral flora
3. Assist the female patient in identification of the urinary meatus and anatomical position of the vagina in relation to the meatus. The use of a mirror, placed so that the patient can visualize perineal structures can be very helpful
4. If postmenopausal female patient has hypoestrogenized perineal tissue, consider transvaginal estrogen medication
5. Teach male patients the correct positioning of the male urethra during insertion of the catheter to minimize trauma as the catheter passes through curved portions of the urethra



6. Instruct patient to be careful to avoid touching the tip of the catheter and/or letting it touch other surfaces. In patients with recurrent infections, consider the use of a “no-touch” catheter or “no-touch” grip or a catheter that has a protective sleeve through which catheter is inserted (e.g. *VaPro Plus*) as seen in the pictures to the right



Hydrophilic coated “no touch” catheter passed through a protected sleeve and drained into an integrated collection bag.

7. Use of a generous amount of lubricant along the length of the catheter (especially male patients) since dry catheters may cause excoriations in the urethra leading to an entry point for bacteria contamination
8. Keep bladder as empty as possible by having patients catheterize at least 4–6 times a day, approximately every 4–6 hour (h) or as often as needed to keep catheterized volume ≤ 500 mL. Keeping the bladder as empty as possible will prevent over-distension of the bladder and increases in intravesical pressure, all of which will preserve an adequate blood supply to the bladder wall
9. Encourage use of a new catheter each time performing IC. Most catheters are manufactured and packaged for single sterile use. Never reuse a hydrophilic coated catheter
10. If patient also has irritative bladder storage symptoms (e.g., urgency, frequency), consider prescribing an anticholinergic/antimuscarinic medication
11. Drink adequate amount of water so that urine is light yellow to yellow all day long. The color of urine can be a quick way to know if fluid intake is adequate (light) or inadequate (dark). If the color gets dark or urine has foul smell, increase water intake
12. Acidification of the bladder may prevent bacteria growth. In the non-catheterizing populations, cranberry capsules and juice have been shown and recommended to help prevent the growth of bowel bacteria in the urethra and the bladder
 - Cranberry ingestion may be contra-indicated in some patients (e.g., those prone to oxalate or uric acid calculi)
 - Cranberry is contraindicated in patients on anticoagulation therapy and should not be recommended to this group
13. Lactobacillus in the diet (yogurt) has been shown to prevent *E. coli* from growing in the urethra
14. Hiprex 1000 mg combined with Vitamin C 1000 mg capsules twice daily is thought to acidify urine enough to prevent bacterial growth in the bladder and is recommended in patients with recurrent UTIs

Management Strategies for Infection Prevention

Several mechanical strategies have been developed to prevent UTIs in individuals who use urinary catheters. These strategies include use of sterile technique, closed-system kits, coated catheters, and catheterization on a more frequent basis.

Ensuring adequate bladder emptying by frequency of catheterization may prevent UTI. Woodbury et al. [56] noted that patients who catheterize infrequently (once/day) were at greater risk of developing a UTI. This was probably related to higher volumes of urine in the bladder at the time of catheterization and longer dwell times of the bacteria in the bladder.

Fluid management for persons with NLUTD can be a challenge. Fluid restrictions of 2 liter per day (L/day) are often applied for persons using IC. In addition, individuals may need to restrict fluid intake before bedtime. Many individuals need to catheterize one or more times during the night, especially if a significant postural diuresis occurs. Dry mouth, which may occur with antimuscarinic medications routinely used to improve urine storage capacity, can further complicate fluid management. There are no prospective studies specifically evaluating optimal fluid intake in persons with SCI&D [28].

Medical strategies for the prevention of UTIs in individuals with SCI&D have been largely unsuccessful. Therefore, identification of novel agents that can successfully reduce rates of UTIs in individuals with SCI&D is an important clinical and research objective. The following sections review the evidence for UTI prevention when using these strategies.

Antibiotic prophylaxis: Antibiotics are not indicated unless signs or symptoms of illness are present. Signs of systemic illness or sepsis are obvious indications for treatment. Other signs, such as changes in the degree of spasticity, may or may not indicate a need for antimicrobial therapy. Furthermore, improvement of symptoms after antibiotic treatment does not necessarily correlate with permanent eradication of the infecting organism. Reid [62] reported persistence of antibody-labeled bacteria in the bladders of persons with SCI&D on antibiotic therapy. Use of antibiotic prophylaxis, which is often successful in individuals without neurogenic bladder dysfunction, is less effective in the population with SCI&D. This may be because of rapid recolonization and development of bacterial resistance. In addition, non-antibiotic-based medical therapies, including methenamine salts (mandelate or hippurate), have largely been unsuccessful.

Nonantibiotic Prophylaxis: A multitude of over-the-counter and prescription products exist for prevention or treatment of UTIs. Many of these products are poorly studied, studied in limited populations, or have been studied with mostly negative or conflicting results. The wide variety of agents attest to the scope of UTIs as a public health problem.

- *Cranberry:* Cranberry products have been shown to reduce the ability of bacteria to adhere to the urinary tract

walls. The active components in cranberry, known as proanthocyanidins (PACs), are large condensed tannin molecules with unusual A-type linkages exhibiting strong bacterial anti-adhesion activity [63]. Thus, PACs are thought to prevent bacterial adhesion to the bladder wall. Results with standard cranberry preparations have been mixed. In the largest study to date, Lee and colleagues [64] found no benefit of oral cranberry capsules, methenamine hippurate, or a combination in preventing UTIs. Hess et al. [65] reported UTI reductions in 47 male patients with SCI&D for any given month while on cranberry over a 6-month period. However, almost 75% of this group used external/condom catheters as their primary method of bladder drainage, making results difficult to interpret. Linsenmeyer et al. [66] in a 4-week study found no difference in bacteria or leukocyte counts for patients with SCI&D randomized to cranberry supplementation compared with a placebo.

Jepson and Craig, in a Cochrane review published in 2012 [67], reported that “there is some evidence that cranberry juice may decrease the number of symptomatic UTIs over a 12-month period, particularly for women with recurrent UTIs. Its effectiveness for other groups was less certain. The large number of dropouts/withdrawals indicates that cranberry juice may not be acceptable as a long-term treatment option. However, properly designed studies with relevant outcomes are needed.” The investigators concluded that cranberry products cannot be recommended for prevention of recurrent UTIs. More recently, a cranberry supplement with a higher concentration of the presumed active ingredient, proanthocyanidins, has shown efficacy in women [68]. Studies in SCI & D have not been completed, although more concentrated proanthocyanidins with standardized potency are available and being studied [28]. The in vitro effects of cranberry proanthocyanidins in preventing adhesion by P-fimbriated uropathogenic *Escherichia coli* are well described. Specifically, a dose response relationship has been established between proanthocyanidins and a decrease in bacterial virulence [69, 70]. However, only a few in vitro trials have examined the use of cranberry ingredients to reduce the recurrence of UTIs in patients in the general population over an extended period [68, 71, 72]. Comparisons are difficult to make because the supplements used and amount of proanthocyanidins present in commercially available preparations are not standardized [63].

- *D-Mannose:* Products containing D-mannose alone or in combination with cranberry based compounds (e.g., Cran-Actin [Solaray, Neutraceutical International Corp, Park City, UT]) are frequently used. Kranjcic and colleagues found a lower risk of recurrent UTIs in women taking D-mannose powder (15%) or nitrofurantoin (20%) versus no prophylaxis (60%) during a 6-month period [73, 74]. In addition, the D-mannose group had significantly fewer side

effects. The study excluded women with interstitial cystitis, diabetes, urinary tract anomalies, or those taking hormone therapy. We found no studies of D-mannose specifically in persons with SCI&D. Research with investigational mannosides (which is found in D-mannose) to prevent bacterial adherence is ongoing [75].

- **Methenamine:** Kevorkian et al. [76] found a lower occurrence of UTIs in a small group of persons with SCI&D taking methenamine plus urinary acidification with ammonium chloride, compared to no treatment. As mentioned earlier, Lee et al. [64] found no effect of methenamine alone. There are also a variety of prescription products containing methenamine mandelate or hippurate combined with methylene blue, salicylates, and urinary acidifiers (benzoic acid) or pH buffers (sodium phosphate). Whether these cocktail formulations have superior efficacy is unknown, because these agents are not well studied [28]. Recent CAUTI guidelines state that methenamine salts should not be used routinely for prevention, but when used, urinary pH should be maintained lower than 6.0 [25].

Bacterial interference: Darouiche and colleagues, in two separate prospective studies [77, 78], have found that persons whose bladders were colonized with *E. coli*, 83,972 were significantly less likely to develop a UTI during follow-up. Beereport and colleagues [68] performed a recent review and meta-analysis of randomized controlled trials of nonantibiotic prophylaxis for adults with recurrent UTIs. These investigators evaluated the efficacy, safety, and tolerability of available agents. Seventeen studies met the criteria for analysis. The oral immunostimulant OM-89 decreased the rate of UTI recurrence, with a good safety profile. However, there are no specific studies of this agent, derived from heat-killed *E. coli* serotypes, in persons with neurogenic bladder dysfunction. These investigators' meta-analysis also reported efficacy for cranberry in reducing UTI recurrence in two studies.

Coated catheters: Catheters coated with silver or antibiotics such as nitrofurazone have been developed to potentially reduce the frequency of CAUTIs. Most of these are indwelling/Foley type catheters. An intermittent hydrophilic single-use catheter coated with nitrofurazone was available but has been taken off the market. An in vitro study of *E. coli* and *E. faecalis* found that silver impregnation had little effect on bacterial adherence and nitrofurazone had a significant effect for only the first 5 days [79]. Intermittent catheterization would present a different challenge, as the catheter is only in contact with the urethra for a brief period of time.

Other studies involved indwelling coated catheters, rather than those for IC. A large multicenter trial [80] evaluating short-term use of antimicrobial catheters in hospitalized adults found no evidence supporting their routine use. Neither silver-coated nor nitrofurazone-coated catheters produced clinically significant reductions in CAUTI in a ran-

domized trial of hospitalized adults. Numerous others have assessed silver-coated or nitrofurazone-coated catheters, some finding short-term reductions in bacteriuria or CAUTI [81]. However, long-term evidence is lacking.

A systematic review by Shamout and colleagues [8] found that although results reported in the literature are inconsistent, single-use HC catheters have an estimated UTI incidence between 40 and 60%, compared with 70–80% UTI prevalence in observational studies of multiple-use catheters.

Bladder irrigation is not recommended, but may be commonly performed by persons with SCI&D who use chronic IUCs for long-term bladder management. In addition, bladder irrigation with antimicrobial agents, such as neomycin or gentamicin is sometimes used for persons on IC. A temporary reduction in bacteriuria can occur, which may result in the growth of yeast. Antiseptics such as oxychlorosene at varying concentrations have been used for treatment of CAUTIs [82, 83]. However, current guidelines do not recommend routine bladder irrigation, because no evidence shows it reduces CAUTIs [25] and the practice of irrigation may itself increase the risk of a CAUTI. No difference in effectiveness at reducing bacteriuria has been found between saline and other irrigants (acetic acid, polymyxin/neomycin), including antibiotic solutions, in persons with IUCs [84]. In general, irrigation solutions are not believed to be effective in eliminating bacteriuria [85].

Techniques/Procedures for Intermittent Catheterization

Sterile and nonsterile techniques may be used with catheter insertion. Some hospitals support the use of nonsterile technique and specific bladder training programs, but most facilities support the use of sterile technique in restricted areas and in certain patient populations, such as the immunosuppressed [33].

Intermittent self-catheterization can be performed in the supine, sitting, and/or standing positions. The location for performing ISC depends on the patient's daily routine. The most popular location for men performing ISC is the bathroom/restroom, using the toilet to drain the urine (see Fig. 2.35) whereas many women prefer sitting on a chair (see Fig. 2.36). The Patient Education Tools found at the end of this chapter depict varying positions and places for performing ISC for both male and female patients.

Most importantly, the catheter must be inserted in a clean and atraumatic way. The requirements include cleaning hands with soap and water prior to catheter insertion, using a clean catheter and lubricant, if needed, and cleansing the urethra meatal area. Use of water versus antiseptic for peri-urethral cleansing prior to catheterization did not increase the risk for UTI [86, 87] or bacteriuria [88]. Atraumatic insertion requires a proper catheter size, sufficient lubricant,



Fig. 2.35 Male self-catheterizing



Fig. 2.36 Female self-catheterizing with a drainage bag attached to the catheter

gentle insertion through the urethra, and in men, correct position of the penis so catheter passes smoothly through curved portions of the urethra (see Fig. 2.37).

During the rehabilitation phase, sterile IC can be taught to patients with adequate hand function. When patients are discharged home, they are transitioned from sterile IC to intermittent self-catheterization.

Patient-Related Questionnaires

Questionnaires have been developed to assess patient satisfaction with IC. These may assess parameters such as the type of catheter or kit, ease of use, privacy or discreetness,

ease of transport or storage, and other quality of life measures. The Intermittent Catheterization Satisfaction Questionnaire (InCaSaQ) has been found to be reliable, valid, and have good patient comprehension and acceptance [89]. The same group developed the Intermittent Catheterization Difficulty Questionnaire (ICDQ), which was found to be a valid test for evaluating catheter use and patients' difficulties during ISC [90]. The Intermittent Self-Catheterization Questionnaire (ISC-Q) was also demonstrated to be a valid and reliable measure of aspects of ISC-related quality of life [91, 92]. It is questionable whether these questionnaires have been used in clinical practice.

Educating the Patient about Intermittent Catheterization

According to Newman and Willson [1], nursing practice lacks uniformity and standardization in teaching a patient how to catheterize since most nurses base their teaching on learned experience. Initially, many patients have reservations and may be extremely reluctant to perform any procedure that involves the genitalia, but this is basically a "fear of the unknown." Self-catheterization is a technical procedure and the patient must learn how to hold and handle the catheter, how to identify the urinary meatus, and how to care for the catheter. In women, in addition to the assistive devices previously reviewed, the use of a mirror, used at the time of the initial teaching, can assist the woman in identifying the meatus and surrounding structures (e.g., vaginal opening, clitoris). Lapidès et al. [9] found that women may initially use a mirror, but after several days can locate the urethral meatus by palpation and stop using the mirror. There are many devices that incorporate a mirror for perineal visualization, which are shown in Figs. 2.38 and 2.39. The devices shown in Fig. 2.39 are "thigh-spreaders" that are helpful in women who have abductor spasms or are unable to separate their thighs. Women may facilitate self-catheterization by placing a tampon or having a finger on the opposite hand in the vagina to isolate the location of the meatus or using a device shown in Fig. 2.40 that is anchored in the vagina and held against the meatus with holes to insert the catheter. Patients and/or caregivers should demonstrate understanding of, and ability to perform catheterization under the supportive supervision of a nurse.

Patient Information

- *Intermittent Catheterization for Men Patient Education Tool.*
- *Intermittent Catheterization for Women Patient Education Tool.*

Fig. 2.37 Correct position of the male urethra for atraumatic catheter insertion—Courtesy of Diane Newman

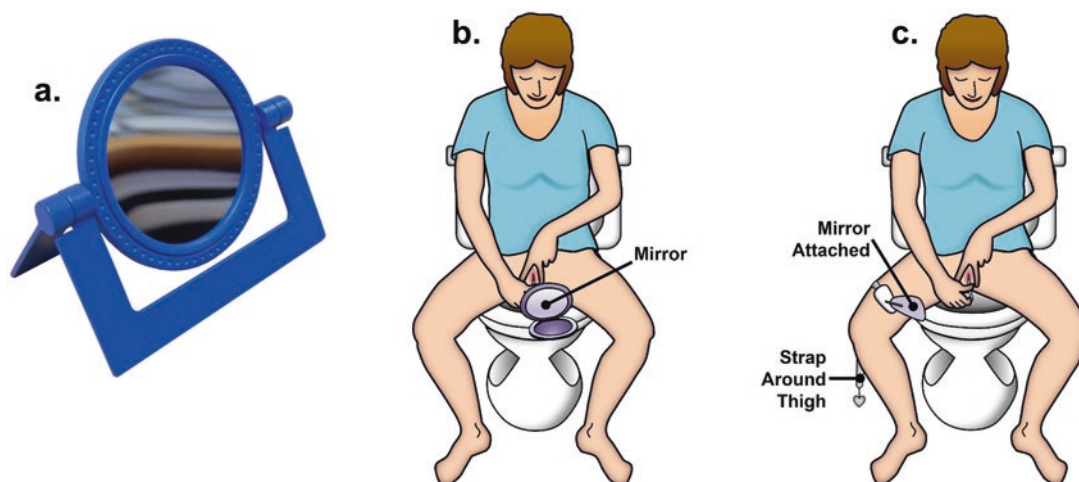
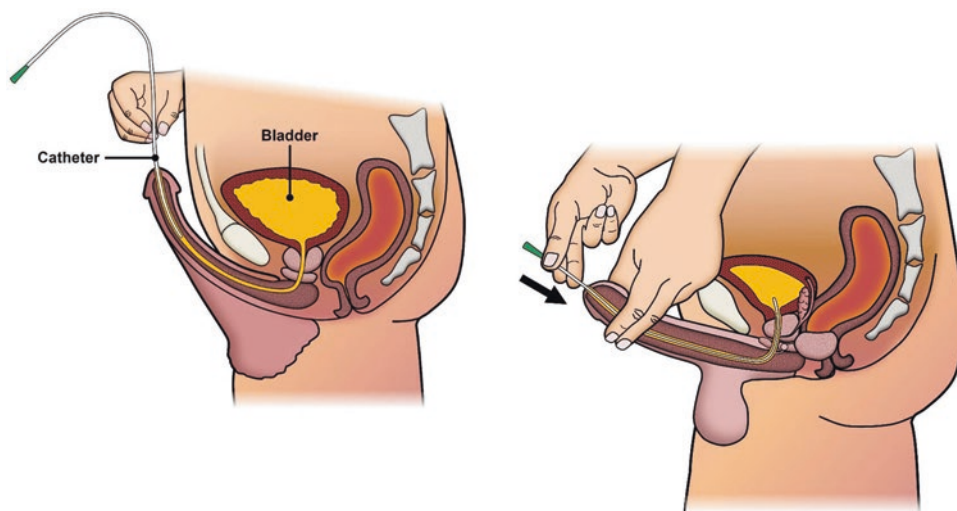


Fig. 2.38 (a) Mirror for visualization of perineum—Courtesy of Wellspect HealthCare. (b) Woman catheterizing using a mirror—Courtesy of Wellspect HealthCare. (c) Woman catheterizing using a leg strap mirror—Courtesy of Wellspect HealthCare

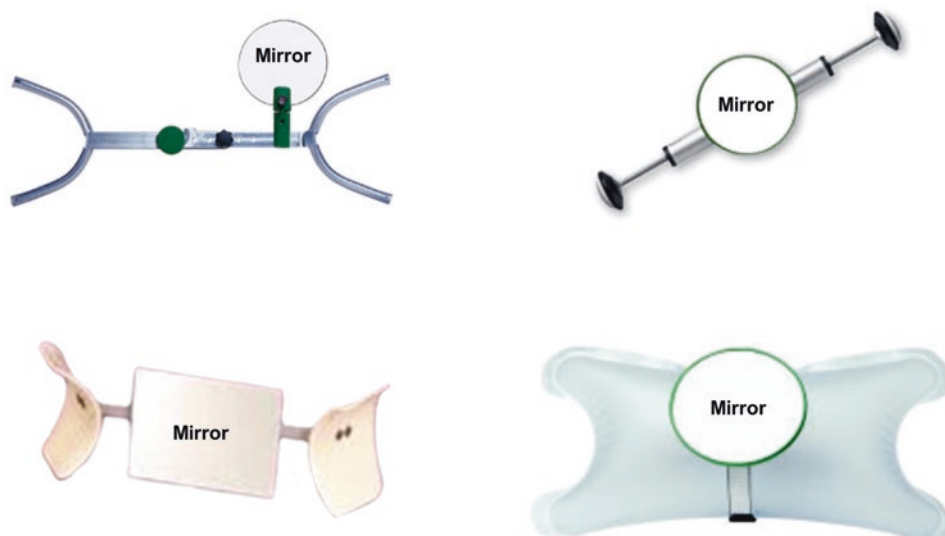


Fig. 2.39 Leg spreaders with mirrors for women, end of device is positioned against upper thigh to keep them separated, mirror is positioned so the perineum can be visualized

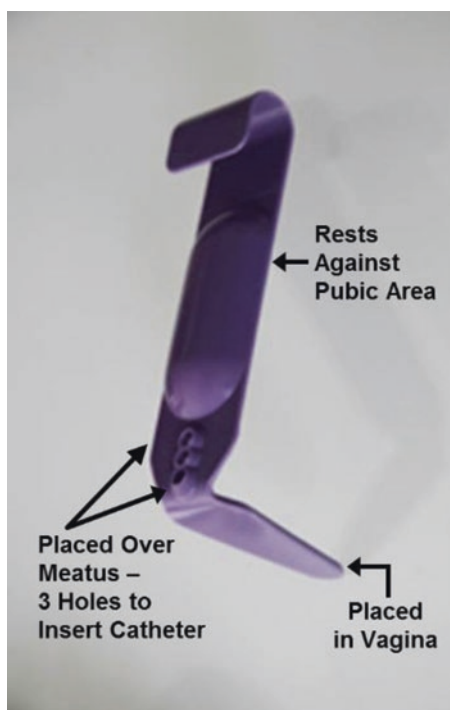


Fig. 2.40 Female device to aid in meatal location. Asta-Cath Female Catheter Guide - A+ Products, Inc.

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Intermittent-Catheterization for Men Patient Education Tool

What Is Intermittent Catheterization?

Intermittent catheterization, called IC, is when you put a tube called a “catheter” into the urethra (which carries urine from your bladder to the outside) and pass it into your bladder to drain urine. Once all the urine is drained, the catheter is removed. Your bladder may need to be drained several times a day. Catheters can be made from rubber, latex, silicone or polyvinyl (PVC) material. A catheter used for intermittent bladder drainage is coated with a lubricant (gel) or a liquid, so that it can be passed easily in your bladder and avoid hurting the urethra. Some are coated with a slippery water solution called “hydrophilic.” Others have no lubricant in the package or on the catheter so you will need to add it. Some are covered in a protective sleeve, so that the catheter is not directly touched. Others require that you break a water packet found in the package that will coat the catheter. All are “single-use” catheters, so they are only used once. Most catheters are about 16 in. long and have a straight or curved tip.

Why Do I Have to Catheterize?

If you cannot empty your bladder completely (called urinating or voiding), you may have certain medical problems. After prostate surgery, you may need to catheterize for a short period of time. People with neurologic (nerve problems) of the bladder may need to catheterize for a longer time. You may need to catheterize your bladder several times a day.

What Can Happen if I Do Not Catheterize?

If your bladder is unable to empty, it can cause a number of problems. It can overstretch, causing permanent damage to the bladder muscle and even kidney damage. If urine is left in the bladder for long periods of time, you can develop a bladder infection. Not being able to urinate can also cause pain, urine leakage, bladder urgency, frequent urination, and awakening many times at night to urinate.

What Is the Procedure I Should Follow?

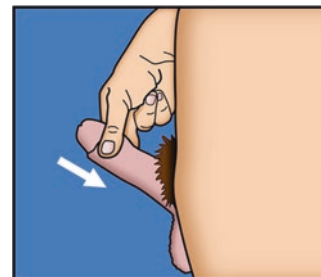
Gather your supplies close to you before you start, so that you can easily reach them. Read the instructions on the catheter package so you know how to use that specific catheter or if you need to prepare the catheter (like needing to coat the catheter with lubricant).

There are several different positions you can try for the catheterization as seen in the pictures on the right. Find one that is most comfortable and works for you. Arrange your clothing so that it does not get in your way.

Wash your hands with soap and water or use a bactericidal soap. Never skip a catheterization because you cannot wash your hands. It is more important to empty your bladder.

If this is the first catheterization of the day, wash the top of your penis, wiping around the opening at the head of the penis with soap and water.

As seen in this picture, with your non-dominant hand (the one you do not use to write with), hold your penis firmly and directly under the head. Then lift up and straighten your penis. Keeping the penis up straight will allow the catheter to pass easily.

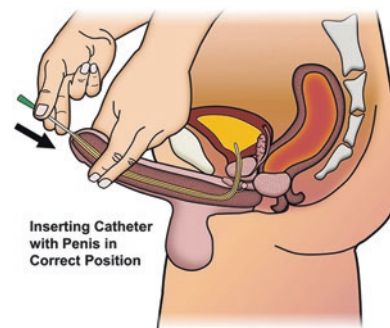


Correct Way To Hold Penis

If you are right-handed, hold the catheter in your right hand 2–3 in. from the tip. The smooth end of the catheter has small holes—this is the end that goes into your bladder, so try not to touch this end. Pass the catheter slowly into the opening of the urethra.

Some resistance may be felt halfway. If this happens, stop and take a few deep breaths, then continue to pass the catheter, gently, but firmly. Do not force the catheter by pushing down on the penis. Push the catheter in 1–2 in. more after urine starts to flow out. Urine may not always flow out. Let the urine drain until it stops. Pushing down on the bladder may help the bladder empty completely.

Hold the catheter tip up as you pull it from your penis so that urine does not spill. You can also pinch the catheter to prevent urine from spilling on your clothes.



How Often Do You Have To Catheterize

You should catheterize *at least* 4 times a day, about every 6 h and at bedtime. Do not let your bladder hold more than 13 oz (around 400 mL) of urine. This is very important as larger amounts may cause problems, like bladder infections.

If your catheterized urine volume is more than 13 ounces (or around 400 mLs), then catheterize yourself more often. Record the amount you urinate and the amount of urine drained from the catheterization.

Taking Care of Your Catheter

These are “single use” catheters, which means you can only use them once so throw the catheter away after you use it. You will use a new catheter each time.

Helpful Tips

- Never force the catheter into your urethra. If you meet resistance and cannot pass the catheter, stop, take a few slow deep breaths, which will cause the urethra to relax allowing the catheter to slide in.
- Control the amount you drink by only drinking between **six** and **eight**—8-oz drinks or a total of 48–64 oz of liquids each day unless you are on a fluid restriction.
- If catheterizing while traveling or working, consider using a pocket or closed catheter system.
- It is important that your bowel movements are regular as this will make it easier for you to empty your bladder completely.
- If you find that you awaken from sleep during the night and feel the need to catheterize, try to not drink after 7:00 pm. This may help you sleep through the night without needing catheterization.

What Problems Might Occur?

- *Bleeding when you catheterize:* There may be a little amount of bleeding when you insert the catheter as it may have irritated your urethra. It should stop but if it does not, call your doctor or nurse.
- *Infection:* Symptoms of an infection include fever, chills, shivering, back pain, blood in your urine, not feeling well, and pain when passing the catheter. You may get one or two bladder infections a year, especially when you first start to catheterize. But, you should not get an infection as long as you wash your hands, and the area around the opening to the urethra is clean. Reusing the same catheter more than once can lead to a bladder infection, so always catheterize with a new catheter.

The Following Catheter Has Been Prescribed for You

- ☐ Clear Plastic (PVC) ☐ Red Rubber (Latex) ☐ Hydrophilic Catheter ☐ Coudé-Curved tip
☐ Closed catheter system/kit ☐ Catheter With a Protective Sleeve
 Size _____ Length _____ Manufacturer _____

Intermittent-Catheterization for Women Patient Education Tool

What Is Catheterization?

Intermittent catheterization, called IC, is when you put a tube called a “catheter” into the urethra (which carries urine from your bladder to the outside) and pass it into your bladder to drain urine. Once all the urine is drained, the catheter is removed. Your bladder may need to be drained several times a day. Catheters can be made from rubber, latex, silicone or polyvinyl (PVC) material. A catheter used for intermittent bladder drainage is coated with a lubricant (gel) or a liquid, so that it can be passed easily in your bladder and avoid hurting the urethra. Some are coated with a slippery water solution called “hydrophilic.” Others have no lubricant in the package or on the catheter so you will need to add it. Some are covered in a protective sleeve, so that the catheter is not directly touched. Others require that you break a water packet found in the package that will coat the catheter. All are “single-use” catheters, so they are only used once. Most catheters are about 6-12 in. long and have a straight tip.

Why Do I Have to Catheterize?

If you cannot empty your bladder completely (called urinating or voiding), you may have certain medical problems. After surgery, you may need to catheterize for a short period of time. People with neurologic (nerve problems) of the bladder may need to catheterize for a longer time. You may need to catheterize your bladder several times a day.

What Can Happen if I Do Not Catheterize?

If your bladder is unable to empty, it can cause a number of problems. It can overstretch, causing permanent damage to the bladder muscle and even kidney damage. If urine is left in the bladder for long periods of time, you can develop a bladder infection. Not being able to urinate can also cause pain, urine leakage, bladder urgency, frequent urination, and awakening many times at night to urinate.

What Is the Procedure I Should Follow?

Gather your supplies close to you before you start, so that you can easily reach them. Read the instructions on the catheter package so you know how to use that specific catheter or if you need to prepare the catheter (like needing to coat the catheter with lubricant).

There are several different positions you can try for the catheterization as seen in the pictures below. Find one that is most comfortable and works for you.

You can sit far back on the toilet or commode with legs spread, stand facing the toilet with one foot on the toilet seat or stand over the toilet. You can also lay on the bed with your legs spread and drain the urine in a container. Arrange or remove your clothing so that it does not get in your way when catheterizing.

Wash your hands with soap and water or use bactericidal soap but never skip a catheterization because you cannot wash your hands. It is more important to empty your bladder.

If this is the first catheterization of the day, wash the area around the opening to your urethra with soap and water.

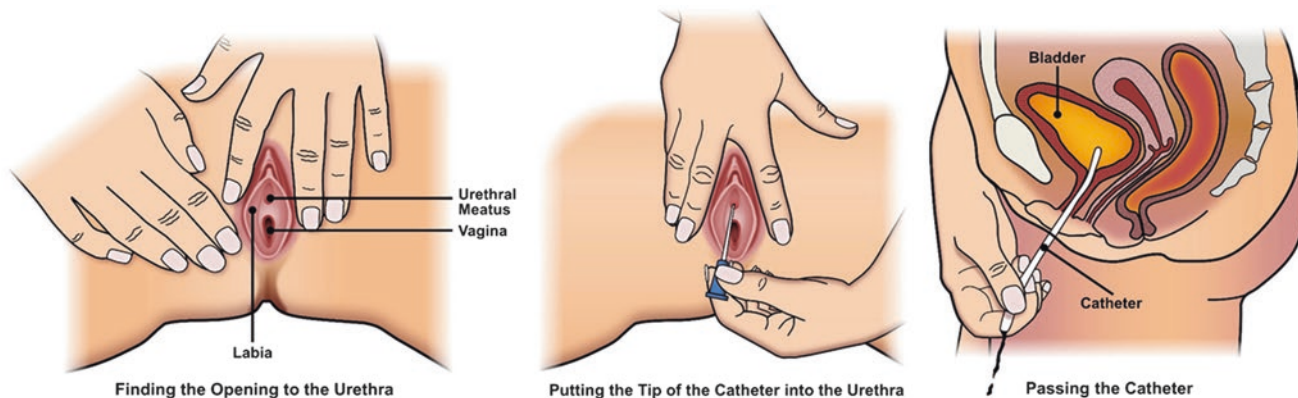


As seen in the first picture below, use your non-dominant hand (the one you do not write with) to separate your labia with your 1st and 3rd fingers and identify your clitoris, urethra (urinary meatus) and opening to your vagina. If necessary, use a mirror to help find these parts.

Rest your non-dominant hand there. With your dominant hand, hold the catheter like a pencil, about 1–2 in. from the catheter tip.

One end of the catheter is smooth with small holes—this is the end that goes into your bladder, so try not to touch that end. Put this end in the urethra (the opening which is found directly above the opening to your vagina and below the clitoris), as shown in the 2nd picture.

When putting in the catheter, point the tip up. When the urine starts to flow, put the catheter in another 1 in. Let the urine drain until it stops. Push with your hand on your stomach to completely empty your bladder. Wait till urine stops draining, then slowly remove the catheter so any urine in the base of the bladder drains out.



How Often Do You Have to Catheterize?

You should catheterize *at least* 4 times a day, about every 6 h and right before you go to bed. Do not let your bladder hold more than 13 oz (around 400 mL) of urine. This is very important as larger amounts may cause problems like bladder infections because the bladder becomes too full of urine.

If your catheterized urine volume is more than 13 ounces or (around 400 mL), then catheterize yourself more often. Record the amount you urinate and the amount of urine drained.

Taking Care of Your Catheter

These are “single use” catheters which means you can only use them once so throw the catheter away after you use it. You will use a new catheter each time.

Helpful Tips

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- If you find that you awaken from sleep during the night and feel the need to catheterize, try to not drink after 7:00 pm. This may help you sleep through the night without needing catheterization.
- If any questions or problems occur, call your doctor or nurse, especially if you are having trouble doing the catheterization or think you may have a bladder infection.

What Problems Might Occur?

- *Bleeding when you catheterize:* There may be a little amount of bleeding when you insert the catheter since it may have irritated your urethra. It should stop, but if it does not, call your doctor or nurse.
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