Intermittent catheterization in neurologic patients: Update on genitourinary tract infection and urethral trauma

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ABSTRACT

Intermittent catheterization is considered the standard of care in most neurologic patients with lower urinary tract disorders. However, in this context, genitourinary tract infection and urethral trauma represent specific challenges. Such conditions have been found to significantly deteriorate quality of life and complicate subsequent treatments. Only optimal prevention associated with appropriate treatment allows for the long-term continuation of such bladder management. Here, we discuss the diagnosis and therapeutic and preventive approaches associated with genitourinary tract infection and urethral trauma in this specific population. This “state-of-the-art” article results from a literature review (MEDLINE articles and scientific society guidelines) and the authors’ experience. It was structured in a didactic way to facilitate comprehension and promote the implementation of advice and recommendations in daily practice. Genitourinary tract infection and urethral trauma associated with intermittent catheterization in neurologic patients should be managed with a global approach, including patient and caregiver education, optimal catheterization with hydrophilic-coated or pre-lubricated catheters and adequate use of antibiotic therapy.

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1. Introduction

Intermittent catheterization, especially self-intermittent catheterization, introduced in the second part of the 20th century [1,2], is now considered the standard of care for most neurologic patients with lower urinary tract disorders [3]. As compared with indwelling catheterization, supra-pubic tube insertion, the Crede maneuver or reflex micturition, intermittent catheterization has repeatedly been reported to improve quality of life and decrease mid- and long-term urinary tract complications [4–6]. Such bladder management aims to protect the upper urinary tract, improve urinary incontinence and decrease urinary tract infection. However, in neurologic patients, the bacteriuria rate is high and repeated urethral manipulations has been associated with urethral trauma and strictures [7]. In this specific population, genitourinary tract infection and urethral trauma constitute challenges because they can affect quality of life [8] and significantly complicate subsequent treatments [9].

This “state-of-the-art” article provides updates regarding the diagnosis, treatment and prevention of genitourinary tract infection and urethral trauma associated with self-intermittent catheterization in neurologic patients. An extensive search of MEDLINE via PubMed and the authors’ experience constituted the basis of the present recommendations.

2. Genitourinary tract infections: diagnosis, treatment and prevention

2.1. Epidemiology–genitourinary tract infection

When talking about genitourinary tract infection, one must clearly distinguish between urinary tract colonization and infection [10]. Urinary tract colonization is defined by the presence of one (or more) microorganism(s) in the urinary tract, without any clinical manifestation. The much-abused term “asymptomatic bacteriuria” refers to the same entity but is not related to any threshold value. For patients undergoing intermittent catheterization, urinary tract colonization corresponds to asymptomatic bacteriuria $\geq 10^2$ colony-forming units/ml [11]. Urinary tract infection refers to the infestation of a tissue by one (or more) microorganism(s) generating an inflammatory response with different types of symptoms varying in type and severity. Therefore, the infection is defined in the general population by the presence of a positive urine culture associated...
with at least one of the following symptoms: fever (> 38 °C), urgency, frequency, supra-pubic or lumbar pain.

Urinary tract colonization is a frequent problem in patients undergoing intermittent catheterization. Classically, males and females do not differ in prevalence [12]. Colonization should be considered a risk factor for genitourinary tract infection [13], among which we can distinguish afebrile infection (cystitis, urethritis) and febrile infection (epididymo-orchitis, pyelonephritis, prostatitis). The incidence of epididymo-orchitis has been estimated at about 0.03/100 patient-days [14] and would be higher with urethral stricture [15]. Of note, recurrent epididymo-orchitis episodes could greatly affect male fertility by increasing the risk of azoospermia [16]. Urinary tract infection is more frequent and the incidence has been estimated as high as 0.41–1.46/100 patient-days [17]. The most frequently isolated microorganisms are E. coli, Proteus, Citrobacter, Pseudomonas, Klebsiella, Staphylococcus aureus and Staphylococcus fecalis. Among patients undergoing long-term intermittent catheterization, some specific microorganisms can also be found: Acinetobacter and Streptococcus fecalis [17]. However, as compared with other bladder management, self-intermittent catheterization in neurologic patients aims in particular to decrease the urinary tract infection rate [18,19].

2.2. Diagnosis - genitourinary tract infection

2.2.1. Physical examination

In neurologic patients undergoing intermittent catheterization, the diagnosis of urinary tract infection is challenging. Indeed, this diagnosis is particularly difficult because of the quasi-constant urinary tract colonization as well as the atypical clinical presentation. Typical symptoms such as urgency, frequency and dysuria are sometimes not present in this specific population—especially those with spinal cord injury (SCI)—and urinary tract infection should be suspected with the following clinical signs: fever, discomfort or pain over the kidney or bladder or during urination, onset of urinary incontinence, malaise, lethargy or sense of unease, increased spasticity and/or autonomic dysreflexia in patients with SCI (upper lesion > T6) and persistent urethral bleeding with long-term intermittent catheterization [20–22]. The presence of odorous or cloudy urine is not specific and should not be used alone to diagnose urinary tract infection [20]. However, epididymo-orchitis is easier to diagnose and should be suspected at the onset of an inflammatory and/or painful scrotum.

2.2.2. Laboratory tests

A urine analysis associated with urine culture and antibiogram should be systematically performed when a urinary tract infection is suspected and a urine sample should be obtained by catheterization before any antibiotic treatment [23]. This process will allow for identifying the microorganism(s) and then adapting the antibiotic therapy. Because leucocyturia mainly reflects inflammation at the urinary tract level, it should not be taken into account to confirm infection, especially in this neurologic population [24]. However, when leucocyturia is not found on urine analysis, another diagnosis, other than urinary tract infection, should be considered. Blood culture should be systematically performed with fever > 38.5 °C. Although positive blood culture findings will not affect the length of antibiotic therapy prescribed, they could provide evidence for a urinary tract infection and guide antibiotic therapy—by identifying a specific bacteria. White blood cell count and C-reactive protein measurement will be of interest only to monitor infection. Epididymo-orchitis should be considered here and treated as a urinary tract infection, not as a sexually transmitted infection. Tetraplegic patients with no sensory function below the neurological level should undergo a urinary tract imaging to eliminate obstructive pyelonephritis.

2.3. Treatment—genitourinary tract infection

2.3.1. Urinary tract colonization

With certain minor exceptions, urinary tract colonization should never be treated in patients under intermittent catheterization [25]. Indeed, even if the antibiotic therapy is considered effective against the microorganism(s) present in urine, bacterial infection will often not be eradicated or will return rapidly [26] and antimicrobial therapy will contribute to the selection of resistant microorganisms [27,28]. Particular cases for which an antibiotic treatment should be initiated are patients undergoing urologic surgery or implantation of prostheses, immunosuppressed patients, pregnant women or for control of nosocomial infection due to a virulent organism prevailing in a treatment unit or an organism causing a high incidence of bacteremia (e.g., Serratia marcescens) [25].

2.3.2. Genitourinary tract infection

Genitourinary tract infection should be treated with an empirical broad-spectrum antibiotic based on the patient’s history and local susceptibility pattern and introduced just after urine and blood sample collection. For patients with increased risk of antibiotic resistance (history of multi-drug-resistant bacteria, recent hospitalization and/or recent antimicrobial therapy), an infectiologist should be consulted. This empirical antibiotic therapy should be secondarily adjusted to urine culture results and maintained for 14 to 21 days. To date, no clinical studies have clearly assessed the optimal length of treatment in this specific population [25]. Therefore, antibiotic therapy should be continued depending on the suspected localization, microorganism(s), comorbidities and patient response. In case of no localizing features, alternative diagnoses must be considered. Furthermore, observation rather than immediate antimicrobial therapy should be considered when the patient is clinically stable and the fever is low grade [25].

2.3.3. Recurrent genitourinary tract infection

Recurrent genitourinary tract infection has been arbitrarily defined by the occurrence of 3 episodes/year or 2 episodes/6 months or 1 episode in the previous 3 months [10]. With recurrent infection, the catheterization technique should be systematically revised and a persistent underlying cause should be sought by a bladder diary and a urodynamic study (to search for detrusor overactivity or impaired bladder compliance) and urinary tract imaging (to search for urinary lithiasis and urinary tract abnormalities). These approaches may involve a physician as well as a dedicated stoma nurse, and a multichannel urodynamic study should be considered. Furthermore, with recurrent epididymo-orchitis, urethrocytostcopy or mic turating cysto-urethrography should be performed to search for an urethral stricture [15].

2.4. Prevention—genitourinary tract infection

2.4.1. Technique: frequency

High micritation volumes have been repeatedly reported as risk factors for urinary tract infection [29,30]. Therefore, catheterization frequency will play a major role in the occurrence of urinary tract complications and should be customized and adapted to each patient. Success will undoubtedly lie in the determination of the most appropriate balance. Catheterization should be performed often enough to limit bladder distension (> 400 cm³) and infrequently enough to limit the negative impact on social life and quality of life. Between 4 and 6 catheterizations per day are advocated [22,31].

2.4.2. Technique: clean intermittent catheterization

It is currently recommended to use a “clean” technique, consisting of introducing the catheter with an atraumatic and non-infecting manner. This technique implies hand washing and
disinfection of the urinary meatus before introducing a clean catheter (single-use catheter or cleaned multiple-use catheter). The “sterile” technique requires a sterile catheter handled with sterile gloves. The technique can only be performed during a limited duration, generally during the acute phase following SCI and in a hospitalization unit with a sufficient number of qualified staff. The “sterile” technique has shown superiority only in asymptomatic bacteriuria [32] or urinary tract infection [32–34] when performed by trained and dedicated nurses and generates an increase in cost as compared with the “clean” technique [32,33].

2.4.3. Material: single-use catheter

To date, single-use catheters have not demonstrated any advantages in decreasing urinary tract infection as compared with multiple-use catheters [23,33]. Furthermore, they are responsible for increased health expenditure. However, some authors insist on the binding character associated with multiple-use catheters and the lack of consensus about the cleaning technique [23]. In practice, multiple-use catheters are considered only when financial resources are limited, mainly in developing countries.

2.4.4. Material: hydrophilic-coated and pre-lubricated catheters

Hydrophilic-coated and pre-lubricated catheters have been found to significantly decrease the risk of urinary tract infection as compared with standard catheters [36–40]. However, they do not seem to have a significant impact on urinary tract colonization. A recent meta-analysis comparing hydrophilic-coated and standard polyvinylchloride catheters concluded a statistical superiority of hydrophilic-coated catheters, decreasing by 3 the incidence of genitourinary tract infection [40]. Furthermore, hydrophilic-coated catheters can delay the onset of first urinary tract infection [39]. If standard polyvinylchloride catheters are used, a lubricant should be added before their introduction. A single-use container with lubricant should then be used to avoid contamination.

2.4.5. Material: urethral introducer

Bacteriuria has occurred after inoculation of peri-urethral bacteria into the urine during intermittent catheterization [41,42]. For a few authors, the systematic use of a urethral introducer, bypassing the distal part of the urethra, would decrease bacteriuria inoculum and prevent the associated urinary tract infection [43].

2.4.6. Add-on therapies: oral prophylactic antibiotic therapy

Although prophylactic antibiotic therapy has been reported to provide a significant but transient decrease in bacteriuria in this specific population, it should be avoided at all costs [27,28,44]. Indeed, such treatment was responsible for the selection and change in urinary bacteriuria leading to the emergence of multi-drug-resistant bacteria and increased incidence of urinary tract infection [44,45]. However, a novel approach, the Weekly Oral Prophylactic Antibiotic (WOPA), has recently been considered. The approach aims to alternate different types of antibiotics, each administered weekly in a single dose during several consecutive months, all during a prolonged period. These antibiotics should be effective for urinary bacteria, well tolerated and present a low selective pressure profile. Salomon et al. [46] reported a significant decrease in incidence of genitourinary tract infection, hospitalization rate and antimicrobial consumption among 38 included patients. Moreover, the authors did not report new cases of colonization with multi-drug-resistant bacteria during a median follow-up of 29 months.

2.4.7. Add-on therapies: intra-vesical prophylactic antibiotic therapy

The intra-vesical instillation of antibiotic substances and the use of antibiotic-coated catheters are controversial. Some authors have reported some encouraging results for bacteriuria (Neomyx-in, Polymixin, Kanamycin-colistin, Gentamicin) [47–50] and reducing urinary tract infection (Neomyxin, Polymixin, Gentamicin) [47,49,50]. However, the therapy could expose patients to severe adverse events and promote the development of multi-drug-resistant bacteria.

2.4.8. Add-on therapies: oral and intra-vesical antisepic substances

The interest of antisepic substances (oral methenamin, intra-vesical instillation of povidone-iodine, intra-vesical instillation of chlorhexidine) has never been demonstrated in preventing genitourinary tract infection among patients under intermittent catheterization [25].

2.4.9. Add-on therapies: cranberry products

A recent Cochrane review (2007) including 10 articles (1049 patients) did not report any advantage of cranberry products in preventing genitourinary tract infection among patients under intermittent catheterization [51].

2.4.10. Add-on therapies: bacterial interference strategy

A novel approach, known as the bacterial interference strategy, was recently proposed. It aims to promote the colonization of the urinary tract with one or more non-pathogenic microorganisms to inhibit the growth of pathogenic microorganisms and decrease the risk of urinary tract infection. This innovative technique is part of the theories recently developed around the concept of microbiota [52]. The use of E. coli 83972-coated catheters could significantly decrease the incidence of genitourinary tract infection [53]. Further studies should be conducted to address the efficacy and safety of this technique.

3. Urethral complications: diagnosis, treatment and prevention

3.1. Urethral complications: epidemiology

Among urethral complications, we classically distinguish urethral bleeding, false passage and urethral strictures. Urethral bleeding episodes are frequent, affecting as many as one-third of patients under long-term intermittent catheterization, mainly males [7]. False passages are also considered classical complications and often occur in case of urethral stricture, bladder-sphincter dyssinergia and enlarged prostate. However, their incidence has tended to decrease for several years because of improved nursing care and the development of new catheters [22]. Urethral strictures constitute a real challenge in this specific population, because the continuation of intermittent catheterization is difficult, which can therefore significantly affect bladder management [9]. Such strictures can be located at the distal part (urinary meatus, membranous urethra) or the proximal part (bulbus urethra, prostatic urethra) of the urethra and would result from repeated urethral trauma. Several risk factors noted include long-term intermittent catheterization [27,54,55], high catheterization frequency [55], forceful urethral manipulations and frequent urethral bleeding episodes [56].

3.2. Urethral complications: diagnosis

3.2.1. Physical examination

Urethral stenosis should be systematically considered with any new onset of difficulty in performing intermittent catheterization and the emergence of recurrent genitourinary tract infection, especially epididymo-orchitis.

3.2.2. Complementary examination

If urethral stricture is suspected, it should be confirmed by urethro-cystoscopy or micturating cysto-urethrography. The
choice between these two techniques will mainly depend on the urologist, the clinical history and accessibility.

3.3. Urethral complications: treatment

3.3.1. False passage

A false passage should lead to transiently stop intermittent catheterizations and introduce an indwelling catheter for 3 to 6 consecutive weeks, associated with a 5-day antibiotic therapy [57].

3.3.2. Urethral stricture

The treatment for urethral stricture will mainly depend on its localization, extension and recurrence. Different techniques are available, including, from the least to most invasive, urethral dilation, meatalotomy, urethrotomy and urethroplasty [56].

3.4. Urethral complications: prevention

3.4.1. Patient education

The prevention of urethral complications should rely on patient education, especially teaching an optimal catheterization technique. Bladder management education programs explaining anatomy and the bladder-sphincter system, using a variety of formats (written, pictures, videos), have been effective in reducing urethral complications [22]. Furthermore, establishing an accessible and complete standardized information could help decrease complications. The information delivered should systematically include teaching an optimal catheterization technique, an explanation about signs and symptoms that should lead to consulting a doctor, and details about the types of available catheters. The catheterization technique should be instructed in a setting that offers complete privacy. A long-term follow-up would allow for regularly re-evaluating the catheterization technique and the patient’s ability and motivation to continue intermittent catheterization [22,58].

3.4.2. Nurses’ education

A knowledgeable and experienced nurse was found important for successful self-intermittent catheterization. Therefore, all caregivers implicated in patient education should understand the cause of bladder and sphincter dysfunction and the reason for proposed treatment [22].

3.4.3. Catheterization technique

The catheter should be introduced gently to avoid any urethral trauma. The patient must have full understanding of anatomy beforehand and be able to easily manipulate the catheter. Several tests and questionnaires are now available to evaluate the patient’s dexterity before beginning self-intermittent catheterization [59,60]. With a hypertonic urethral striated sphincter, the catheter should be inserted up to the sphincter and kept in position for 1–2 minutes before pushing it into the bladder [22]. In this particular situation, some authors have reported the advantage of botulinum toxin A injections into the urethral striated sphincter, so that the patient can continue with self-intermittent catheterization [61]. However, this technique is counterbalanced by an increased risk of infection [62] and is therefore not recommended by current guidelines; further research should be conducted.

3.4.4. Material

Several types of catheters are available for intermittent catheterization, differing by the material used, shape, length, diameter or presence of lubricant and specific coating. However, none can be universally used. Therefore, a variety of catheters should be proposed to the patient, explaining the pros and cons associated with each [63]. Furthermore, the patient should be given the opportunity to try different catheters and choose among them. However, pre-lubricated catheters have been found to prevent urethral complications, with a significant decrease in urethral bleeding episodes as compared with standard catheters [36]. Similarly, hydrophilic-coated catheters have been reported to significantly decrease urethral complications as compared with standard catheters. Regardless, pre-lubricated and hydrophilic-coated catheters have never been compared head-to-head.

4. Conclusion

Several important points should be kept in mind when considering genitourinary tract infections and urethral complications in neurologic patients under intermittent catheterization. Urinary tract colonization should never be treated (except in particular situations), and prophylactic antibiotic therapy should never be prescribed (except for WOPA, under evaluation). Urinary tract infection and urethral complications should be prevented by ensuring an optimal catheterization technique through patient and caregiver education and by using hydrophilic-coated or pre-lubricated catheters. Furthermore, the use of a urethral introducer and bacterial interference strategy could help prevent genitourinary tract infection.

Disclosure of interest

The authors declare that they have no competing interest.

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