

# Evidence-based catheter selection for intermittent self-catheterization: systematic review.



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## Abstract

**Study design:** A systematic review of the literature was used.

**Objectives:** To identify the types of catheters used and to find an optimal type of catheter for intermittent self-catheterization.

**Setting:** The search terms were self-catheteriz(s)ation, bleeding, injury, infection, material, catheter type, length, circumference, shape, coating, packing. Searches were limited to scientific journals, full text accessibility, English and Slovene language, and publication time between 1999 and 2019. We used a four-step PICO search strategy to obtain and validate the literature.

**Methods:** The synthesis of the review was done using the PRISMA tool. The quality of the studies was assessed by two reviewers using hierarchy of evidence.

**Results:** From 440 studies found, 41 were selected according to the quality and purpose of the study. The selected studies were 16 literature reviews, 4 randomized control trials, 20 cohort studies, and one case study.

**Conclusions:** This review may serve as a reference for healthcare workers in caring for a new person with urine retention. It is recommended that nurses and persons together firstly select the technique of self-catheterization, and only after that select the catheter type. The review found that none of the catheter types can be generally recommended for intermittent self-catheterization. Due to the lack of evidence, the selection of the catheter depends primarily on the persons' preference of the catheter type considering selected technique of self-catheterization.

**Keywords:** Evidence-based nursing; Intermittent urethral catheterization; Patient outcome assessment; Quality assurance; Health care

**Abbreviations:** PVC: Polyvinyl Chloride; EVA: Ethylene-Vinyl Acetate; FG: French Gauge;

## Introduction

Intermittent catheterization is used as a gold standard to ensure optimum bladder emptying and is a good alternative to an indwelling catheter [1,2]. It is known as a safe method suitable for long-term use that can protect the upper urinary tract and improve the quality of patients' life with significant voiding problems because of disturbance or injuries to the nervous system, non-neurogenic bladder dysfunction or intravesical obstruction with incomplete bladder emptying [3,4]. Intermittent catheterization is performed when a patient cannot completely empty the bladder with spontaneous urination, and leaving a residual amount of urine (> 100 ml) [2]. It's indispensable for patients with neurogenic bladder, those with bladder prolapse, with obstruction and functional, iatrogenic and congenital malformations, and prostatic enlargement [2,5]. A special feature in the procedure of

intermittent self-catheterization is that it can be performed by the patient himself, his relative or, health professional [3]. Standard guidelines for self-catheterization recommend a clean technique with hands washed. Sterile gloves must be used if intermittent catheterization is performed by a healthcare worker or anyone else other than the patient or a close family member [4]. Clean technique is sufficient when procedure is performed by patient himself, and sterile when is performed by health professionals or careers [3]. Catheter features that have to be considered when choosing a catheter are catheter material, packing, length, circumference, shape, coating and cleaning.

Various catheters are available for performing intermittent catheterization. They can be uncoated or coated with various coatings; and can be for reuse or single-use. Almost all catheters

are available in pediatric and standard men and women measures. There are two types of uncoated catheters: a.) latex catheters, mostly made of polyvinyl chloride (PVC) or ethylene-vinyl acetate (EVA), b.) catheters from red rubber, also content latex and ethylene-vinyl acetate [6,7]. PVC is a cheap, durable, and flexible material. This thermoplastic polymer is usually for single-use and sometimes can be uncomfortable because causes stiffness and allergies. PVC can be produced in harder or softer versions, which affects the correct rigidity of the catheter. EVA is a soft and flexible polymer with good clarity and gloss, barrier properties, low-temperature toughness, hot-melt adhesive waterproof properties, and resistance to UV radiation. The material has little odor and is competitive with red rubber and PVC products [7].

Uncoated catheters are usually used for clean intermittent self-catheterization with the lubricant gel. Coated catheters are intended for single-use, intended to facilitate the procedure and reduce the irritation of the mucous membrane. Therefore, the use of a lubricant gel is not required [7]. But a procedure using coated catheters requires some liquid and has to be water-soaked for about 30 seconds before use. One possibility is the water bag packed in the catheter's wrapper. When the water is spilled by pressing the little water container, the top layer of catheter activates and becomes smooth. A coated catheter can also be already immersed in liquid, and ready for immediate use [7,8]. For watering, it is possible to use drinkable water or saline packed in sealed containers [6]. The length of the catheter is very important because of the anatomical differences in the length of the urethra in men and women, body mass, and special anatomical features of the patient [2].

Thus, there are different lengths of catheters, the standard is from 40 to 45 cm. Firstly, the catheter of this length was used for both, men and women. Nowadays, special catheters are available also for women (length from 20 to 26 cm) [9]. Catheter external circumference is measured in Ch (Charriere), or the FG (French Gauge), and is available in a range from 6 to 24 [7]. The value below 12 FG is for children and from 14 to 22 FG is for adults. A catheter size of 12 to 14 Ch is suitable for women, and 12 to 16 Ch for men [4]. Larger sizes are used for treating strictures. The higher the Ch or FG value, the more the urethra is widespread when the catheter is inserted; the greater the irritation within the urethra; the greater the chance of the formation of urethritis; and the damage of the nearby glands [7]. Catheters can be straight or curved. Most straight catheters are tapered, so they can smoothly penetrate the urethra and allow easy insertion. Some of them have an introducer tip, through which the catheter passes with minimum risk for contamination [1]. The Nelaton catheter is the standard catheter and has a soft, flexible, rounded tip with a straight end. This type of catheter has two lateral eyes for drainage that are often polished for comfort [7]. Curved (Tiemann) catheters are used primarily in male patients with the enlarged prostate gland and also in cases of

urethral stricture. The curved part of the catheter is more tapered and usually is the end of the catheter which facilitates the passage of the catheter through the urethra. This type of catheter has a slightly more bulbous or rounded tip on the end [7,10]. There are also some other shapes of catheter tips, such as flexible rounded tip, pointed tip which is squeezable and has a bendy end, rounded and angular (30 - 45°) concave tip [7].

Different methods are available to reduce the friction between the surface of catheter and urethral mucosa. A lubricating gel can be applied to catheter before each insertion, or a pre-coated catheter can be used to reduce friction without jelly [11]. Catheters could be coated with hydrophilic, antibiotic, antimicrobial, and other substances intended to reduce the damage and friction of mucosa when introduced through the urethra [1]. Hydrophilic catheters have a polymer coating, containing salt which absorbs and binds water to the catheter. Catheter surface becomes thick, smooth, and lubricated in contact with it. Hydrophilic catheters are described as the most sterile catheters because of the reduced possibility of infection due to unnecessary manual application of the lubricant gel [8]. It is also known that, patients who use coated catheters for clean intermittent catheterization suffer less urinary tract infections, asymptomatic bacteriuria, microhematuria, and have a high level of satisfaction [8].

Another important issue in intermittent self-catheterization is the reuse of the catheter. Reasons for reuse are many, in addition to the costs, there is environmental protection as well as lack of knowledge on the safety of single-use catheters [7]. Although there is no scientific information on how to properly clean the catheter for reuse, most patients do not disinfect the catheter between two consecutive uses [6]. Jeong & Oh [11] find out that 5-minutes disinfection with 70 % alcohol provides antimicrobial effects on all 3 different pathogens. Besides, alcohol disinfection does not affect on the catheter material. In general, it is suggested to clean the catheter for reuse with soap or detergent for dishwashing, boil it in water; sterilize it with microwaves for 12 minutes; and/or soak it in antiseptic solution (betadine, peroxide or vinegar) [6,8]. It is also advisable to rinse the catheters under lukewarm running water for at least 30 seconds immediately after use, and then dry it. Not all catheters are appropriate for all patients, and because of that, patients may need to try several different catheters before choosing the right one [1]. The patient should select a catheter with which they are competent and comfortable using [12]. Self-catheterization procedure must be introduced to a patient by a competent nurse specialist who can demonstrate appropriate training and knowledge [1].

The selection of the appropriate catheter is therefore mostly in the hands of the patient [2] and a specialist nurse. Literature describes different types of catheters, but rare report a clear position on the optimal catheter which would be the first suggested for a new patient that needs intermittent self-catheterization. This

paper aimed to perform a literature review related to the catheter selection for intermittent self-catheterization. The purpose was to describe in detail the types of catheters and their special features through benefits and limits for the patient. The following research question was developed: What is the evidence for recommending an optimal type of catheter for intermittent self-catheterization, considering patient outcomes?

**Methods**

A descriptive research method, through a systematic review of the literature, was used. The research focused on self-catheterization, various types of catheters, the necessary material for intermittent self-catheterization, and patient outcomes. We used a four steps PICO search strategy [13]: P (patient, problem, population) patient performing self-catheterization; I (intervention)- self-catheterization; C (comparison, control); O (outcome) - bleeding, injury, infection. The search terms were self-catheterization, bleeding, injury, infection; and the corresponding Slovene terms. Boolean operators (AND, OR) were used. Searches were limited to scientific journals, full-text accessibility, and English and Slovene language journals published between 1999 and 2019.

Most of the literature was found in the Cochrane Library, MEDLINE, CINAHL, and PubMed databases. We used various browsers, such as EBSCO Host, ProQuest, Springer Link, and Google Scholar. An archive of the Slovenian Nursing Review was also examined. The literature search was performed in July

2019. A total of 440 records were identified. The abstracts of these records were screened against the inclusion criteria and the research question. 399 were excluded. The remaining 41 articles were read in full and judged explicitly against inclusion criteria. This studies were published between 2002 and 2017. The literature review was conducted according to the international standard using Preferred reporting items for Systematic Reviews and Meta-Analyses (PRISMA) [14] (Figure 1).

After considering compliance with the research question, analysis considering the methodological characteristics followed [15]. Most studies were of good quality: namely 17 in category 1 (excellent), 23 in category 2 (good), and 1 in category 4 (poor). Line-by-line coding was undertaken. Codes were identified by the first author and afterward repeated by the second author. Inconsistencies were resolved by consultation. To synthesize the extracted data, we first divided the results into categories, and after that into themes that were found to be the most discussed in the literature. The findings were pooled and are presented in narrative form.

**Results**

From 440 records found, 41 were finally selected for analysis (Table 1). We included 14 literature reviews, 5 randomized control trials, 21 cohort studies, and one qualitative studies. The themes identified in this search were four (Table 2): urinary tract infections, period of use, technique, and patients' satisfaction (Table 3).

**Table 1:** Basic search terms by database.

Search steps	Database			
	Cochrane Library	Medline, Cinahl	ProQuest	PubMed
1	patient	patients	patients	intermittent self-catheteriz(s)ation
2	self-catheteriz(s)ation	intermittent urethral catheteriz(s)ation	urethral self-catheteriz(s)ation	hydrophilic catheter
3	1 and 2	urethritis	bleeding, injuries, infections	urethral self - catheterization, hydrophilic catheter
4	bleeding, wounds, injuries, infections	-	-	-

**Table 2:** Characteristics of included studies.

Author, year, country,typology	Research aim	Sample	Fundamental findings
[16] Turkey Quantitative study Retrospective cohort study	To evaluate spinal cord injury patients' compliance with a bladder emptying method over a long-term period after discharge, and determine the frequency of urinary tract infections.	164 new spinal cord injured patients were noted at discharge from the rehabilitation centre and follow-up. Patients were questioned by phone as to whether they continued the initial bladder emptying method at follow-up, reasons for discontinuation, and the history of treated urinary tract infections.	Clean intermittent catheterization is a reliable and effective method in selected spinal cord injury patients. Despite changes in the bladder emptying method, clean intermittent catheterization was the most preferred method at long-term follow-up. 53.3% of patients used a PVC catheter, and 46.7% a hydrophilic catheter. Patients who used hydrophilic catheters suffered less urinary tract infections and microhematuria, and reported a high level of satisfaction.

<p>[17] Great Britain Systematic review and meta-analysis</p>	<p>To find the most effective and cost-effective catheter for patients who perform intermittent self-catheterization in home care.</p>	<p>Medline, Embase, Cochrane and Cinahl databases from 2002 to 18 April 2011 were searched to identify studies comparing hydrophilic, gel reservoir, and non-coated intermittent catheters, and these were then reviewed. Eight studies were included in a systematic review. Most were performed on male patients with spinal cord injury.</p>	<p>Type of catheter seems to play little role in the risk of symptomatic urinary tract infection. A large cost preference can be attributed to a clean uncoated catheter. Because of the lack of evidence on uncoated catheters for single use, patients should choose between hydrophilic catheters and catheters with gel reservoirs.</p>
<p>[39] Quantitative study Prospective cohort study</p>	<p>To compare the satisfaction of paediatric patients with neurogenic bladder who use coated hydrophilic and uncoated catheters. The main hypothesis was, based on their limitations, patients might have problems using hydrophilic catheters.</p>	<p>30 paediatric patients with neurogenic bladder with a median age of 13.5 years answered the questionnaire. 26 were self-catheterized, and six had the Mitrofanoff procedure. 10 children received catheterization by the urethra and would be ready to proceed with a hydrophilic catheter.</p>	<p>Most patients prefer a conventional catheter, which would not be exchanged with a hydrophilic one because they were seen as too slippery during the manipulation and insertion, too stiff, and needing more preparation and catheterization time. Males catheterizing per-urethra and patients having stoma that need long catheters had problems with the excess of lubricant.</p>
<p>Bozkurt et al., 2014, Turkey Qualitative, case study</p>	<p>To discuss the case study, diagnosis, and treatment of urethro-gluteal fistula and a very large pelvic urinoma that developed as a result of the use of clean intermittent self-catheterization for emptying a neurogenic bladder.</p>	<p>A 36-year-old obese diabetic paraplegic patient with spinal cord injury. He has been implementing clean intermittent self-catheterization with single-use hydrophilic coated catheters for the last five years.</p>	<p>A complication induced by clean intermittent self-catheterization, which was rarely reported in the literature previously, was presented. A fistula extending from the posterior urethra to the gluteal region was detected, the patient was followed up by suprapubic catheterization.</p>
<p>Buckley et al., 2014 Literature review</p>	<p>To review all older and newer articles on the subject of dilation, internal urethrotomy, and the insertion of a stiffener in the stricture of the anterior part of the urethra.</p>	<p>Review of 50 sources of literature. Articles were included that met the criteria set by the International Consultation on Urological Diseases urethral strictures committee and were sorted by level of evidence using the Oxford Centre for Evidence-Based Medicine criteria adapted from the work of the Agency for Health Care Policy and Research as modified for use in previous International Consultation on Urological Diseases projects.</p>	<p>Review of the scientific literature about anterior urethral urethrotomy/dilation/stenting was performed. Intermittent self-catheterization can be a form of prevention of the recurrence of urethral stricture.</p>
<p>Böthig et al., 2012, Germany Quantitative retrospective cohort study</p>	<p>To analyse the correlation between bladder management and age in respirator-dependent high-tetraplegic patients.</p>	<p>A questionnaire was sent to 56 tetraplegic respirator device-dependent spinal cord injury patients. Their A questionnaire was sent to 56 tetraplegic respirator device-dependent spinal cord injury patients. Their scores concerning urological morbidity were reviewed. For analysis reasons, they were divided into three groups: suprapubic catheterization 38 patients, intermittent catheterization 12 patients, and others 6 patients.</p>	<p>Patients with suprapubic catheterization suffered fewer urological complications and tend to score a better quality of life. Suprapubic catheterization was recommended as a serious alternative for these selected patients, and the necessity of close urological surveillance at least annually was underlined.</p>
<p>[22] North America Quantitative prospective cohort study</p>	<p>To determine whether intermittent catheterization with a hydrophilic coated catheter postpones the onset of the first urinary tract infection and reduces the number of symptomatic urinary tract infections in patients in the acute phase of spinal cord injury compared to the use of an uncoated catheter.</p>	<p>There were 224 patients with spinal cord injury that were performing intermittent catheterization for less than three months. They were followed up during hospitalization as well as rehabilitation, and up to three months after their discharge to the home environment, for a maximum of six months.</p>	<p>The use of coated hydrophilic catheters reduces the incidence of urinary tract infections associated with complications, treatment costs, prolonged rehabilitation and reduces the appearance of organisms resistant to antibiotics.</p>

Casey et al., 2009 Literature review	With a literature review, determine the number of cases of squamous cell bladder cancer, a description of the risk factors for its occurrence, a description of a case, and determine whether there is a validated program for detecting patients with risk factors for the development of this type of bladder cancer.	26 sources of literature were included in article. Seven case reports were found and the article represents the eighth – the first case described in a patient who had a continent appendicovesicostomy.	Only seven cases of squamous cell bladder cancer are mentioned in the literature about patients who perform clean intermittent self-catheterization. The risk factors are: recurrent urinary tract infections, keratinizing squamous metaplasia, and local damage to the mucous membrane of the urinary tract during the intermittent self-catheterization procedure.
[36] Systematic review and meta-analysis	To find out the effectiveness of cleaning the urinary meatus with water or saline compared to disinfection through a systematic review and meta-analysis.	After consideration of inclusion and exclusion criteria, five studies were selected as important for this study.	There is some evidence that the use of water, saline or disinfection for cleaning the meatus before catheter insertion reduces the occurrence of urinary tract infections, but this is not statistically significant.
[29] France Quantitative interventional, multicentre, open-label, randomized and crossover study.	To describe the current catheterization habits of French neurogenic bladder patients using intermittent catheterization, and to evaluate the use, reliability, patient comfort and acceptance of the new 'no-touch' VaPro catheter.	Patients were recruited from 11 centres in France. 106 patients, aged 18 - 65 years with neurogenic bladder using intermittent catheterization at least four times a day, were randomly selected into two groups.	The VaPro catheter is an acceptable and reliable alternative to the existing hydrophilic-coated 'no-touch' catheter.
[19] Belgium Quantitative cohort prospective study	To compare the performance of hydrophilic and PVC catheters. The main hypothesis was that coated catheters cause fewer complications in terms of symptomatic urinary tract infections and hematuria.	57 patients older than 16 years completed the 12-month study. Primary endpoints were the presence of symptomatic urinary tract infection and hematuria. Secondary endpoints were the development of urethral strictures and convenience of use.	Fewer patients using the hydrophilic coated catheter (64%) experienced one or more urinary tract infections compared to the uncoated PVC catheter group (82%). There was no significant difference in the number of patients experiencing bleeding episodes in those using hydrophilic or PVC catheters, and no overall difference in the presence of hematuria, leukocyturia and bacteriuria.
[33] France Quantitative cohort study	Prepare and validate a tool (questionnaire) for evaluating patient satisfaction with intermittent self-catheterization.	A simple questionnaire with eight questions was prepared and validated. 113 patients with neurologically-affected bladder were included. Four main themes were identified, namely: packing, lubrication, catheter and post-catheterization.	The understanding and acceptance of the questionnaire by patients were good. The questionnaire was well designed, as it can be used to compare the comfort and efficacy of different types of catheters and to recognize the need to change the type of catheter in patients expressing dissatisfaction.
Håkansson, 2014 Systematic literature review	To determine whether catheters for reuse are as safe as single-use catheters and the reasons for using reusable catheters in some countries (e.g. Australia, Canada, and the United States).	A review of 50 articles	Further clinical studies are needed to confirm Further clinical studies are needed to confirm the difference in the occurrence of complications according to catheter reuse. In addition, a non-infectious and non-traumatic technique is recommended.
James et al., 2014, North America Quantitative cohort study	To describe the use of urinary catheterization among patients with multiple sclerosis and determine the differences between those who report a positive impact compared to those who report a negative impact of this treatment on the quality of life.	There were 5,143 respondents with current urine leakage, of whom 1,201 reported current catheter use.	Of the current catheter users, 304 respondents reported that catheterization negatively impacted their quality of life, 629 reported a positive impact, and 223 reported a neutral impact. Urinary catheterization does not appear to have a generally negative impact on patient quality of life.

<p>[26] Thailand Quantitative cohort retrospective study</p>	<p>To find out the safety of the use of silicone catheters for reuse in terms of properties, smoothness, and stiffness, and the effects on the development of urinary tract infections and irregularities.</p>	<p>28 male patients with spinal cord injury who performed clean intermittent self-catheterization with a silicone catheter for reuse for at least one year were included. Data were obtained from medical examinations, urethrography, ultrasound, measurements of serum Cr and Ccr and examination of catheters under an electronic microscope.</p>	<p>Patients used one catheter for approximately three years, which is not associated with damage to the urethra and upper urinary tract. Such use is associated with a higher risk of developing urinary tract infections. After two years of use, the catheter becomes rigid and coatings are formed on the surface, but the lumen of the catheter remains in good condition. Further research is needed to determine the appropriate time for using such a catheter.</p>
<p>[24] Canada Quantitative cohort study</p>	<p>To study the method of performing intermittent self-catheterization and to identify the risk of urinary tract infections in disabled athletes.</p>	<p>The survey questionnaire was completed by 61 paralympians from 15 different countries, who have been performing intermittent catheterization for at least one year.</p>	<p>1/3 of the people involved used the same catheter several times, from two to 200 times. They came from developing countries (Brazil, Colombia). Those who used one catheter several times experienced urinary tract infection four times a year; those who used it once only experienced an infection on average once a year. The procedure was performed on average six times a day, which was not associated with the onset of urinary tract infections.</p>
<p>Kriz and Relichova, 2014, Czech Republic Quantitative cohort study</p>	<p>To present a system of urological care for patients with cervical spinal cord injury in the Spinal Cord Unit in Prague.</p>	<p>41 out of 412 patients hospitalized with acute spinal cord injury with motor complete at the C4–C7 motor level and with sufficient follow-up duration were selected. Patients were trained using a male bladder catheterization model (37 with a transurethral catheter and four with a suprapubic catheter) to perform intermittent catheterization using an ergohand device, and were later encouraged to perform self-catheterization.</p>	<p>Patients with cervical spinal cord injury below the C5 motor level can learn self-catheterization, which increases independence and decreases the risk of urinary infection and stone formation.</p>
<p>Ku et al., 2006 South Korea Quantitative cohort retrospective study</p>	<p>Evaluate the risk of developing epididymo-orchitis in patients with spinal cord injury.</p>	<p>140 male patients injured before 1987 were followed up.</p>	<p>Almost 28% of cases of epididymo-orchitis occurred after 17 years of spinal cord injury. The complication was more common in patients who had a history of constriction of the urethra and those who performed clean intermittent catheterization compared to an indwelling urinary catheterization. Clean intermittent catheterization was not an important risk factor.</p>
<p>[30] France Literature review</p>	<p>To review the literature and determine the recommendations for therapeutic education programs for intermittent self-catheterization.</p>	<p>With a review of the Medline, Pubmed and Cochrane Library databases using the keywords neurogenic bladder, intermittent catheterization, teaching, self-care, educational needs, and therapeutic education used, a total of 91 references were included in the article. Seven of these were clinical studies on tools and scales used in learning about self-catheterization and were analysed.</p>	<p>Patient education needs to have a structured procedure to evaluate the ability to understand, accept, and perform clean intermittent self-catheterization. Teaching self-catheterization is well known; nevertheless, the usefulness of educational therapeutic programs remains to be demonstrated.</p>
<p>[32] United Kingdom Quantitative cohort study</p>	<p>A repeat study performed on men, now also on women, assessing the characteristics of the HydroSil Go catheter and its use by women.</p>	<p>37 patients aged between 24 and 83 years completed the initial and follow-up study questionnaires.</p>	<p>Patients rated the catheter as discreet, comfortable and easy to handle when learning intermittent self-catheterization for the first time. This confirms the findings of the previous survey conducted on men.</p>

Lubahn et al., 2014, United States of America Quantitative cohort, prospective study	To evaluate the patient perceptions of regular intermittent self-dilation in men with urethral stricture.	85 patients with a median age of 68 years were included.	Most patients with urethral stricture who perform intermittent self-dilation evaluate the difficulty and pain as moderate, and inconvenience as low. Despite this, they report a poor quality of life.
Medical Advisory Secretariat, 2006, Canada Literature review Evidence-based analysis	Evidence review of the efficacy of the use of hydrophilic catheters in patients who perform intermittent catheterization.	Five randomized control trials were identified that compared hydrophilic catheters to standard catheters. Two studies used reusable catheters in the control arm, while the other three trials used single-use catheters in the control arm. All five trials focused mainly on males requiring intermittent catheterization.	There is insufficient evidence to indicate whether hydrophilic catheters are associated with a lower rate of urinary tract infections and a higher level of quality of life patients who perform intermittent catheterization.
Mistry et al., 2007 Texas Quantitative experimental study	To determine whether the pre-introduction of the hydrophilic catheter following the failure of the introduction of an uncoated catheter contributes to the subsequent easier introduction of the uncoated catheter.	A total of 44 males over 12 years of age with acute urine retention in which the placement of an uncoated catheter was unsuccessful were included in the study to avoid invasive manoeuvres or surgical procedures. The catheterization experiment was then performed using a hydrophilic catheter.	Of the 44 males, for 34 the introduction of the hydrophilic catheter was successful and relieved discomfort and acute urine retention. After the removal of the hydrophilic catheter, these patients were also able to insert an uncoated catheter. Long-term catheter insertion for monitoring acute urine retention was possible in 30 patients. Hydrophilic catheters should, therefore, be part of the mandatory equipment for the treatment of men with acute urine retention.
Moore et al., 2006, Canada Quantitative randomized, clinical study	To find out the connection between the urinary tract infections in patients after spinal cord injury during rehabilitation according to the performance of the clean or sterile technique of intermittent self-catheterization.	36 patients with spinal cord injury who need intermittent catheterization were randomly divided into two groups according to the technique for performing the procedure: 16 patients perform an aseptic technique using a sterile material for single use, 20 patients who perform the clean technique use a catheter for single use, no-touch technique and cleansing the meatus with chlorhexidine.	The average duration of urinary tract infection in the group with clean catheterization was three weeks, and in group with aseptic catheterization it was 3.6 weeks. It was discovered that clean intermittent catheterization in a rehabilitation centre does not increase the risk of urinary tract infection and is much cheaper in comparison with the aseptic technique.
Nnabugwu et al., 2014, Nigeria Quantitative cohort study	To seek the opinion of patients already using indwelling catheters regarding the practice of self-catheterization.	A total of 108 patients and 59 patient relatives completed the questionnaire.	A selected group of patients and accompanying relatives in a low-resource setting are willing to learn and practice self-catheterization.
Pelter and Stephens, 2008, USA Quantitative cohort study	To test whether the Cath-Assist would decrease the time required for catheter insertion, increase the likelihood of inserting the catheter on the first attempt (improved accuracy), and minimize patient discomfort compared to the traditional catheterization method.	40 patients, 23 nurses and two nursing students participated in the study.	Most nurses thought the Cath-Assist was easy to use and easy to learn how to use, and they would recommend the device to a colleague or choose to use the device again. The findings of this study did not show that the Cath-Assist decreased the time required for catheter insertion or improve accuracy. There was no difference in patient discomfort compared to the traditional catheterization method.

<p>[31] Systematic literature review.</p>	<p>To determine whether there is an optimal technique of intermittent self-catheterization that nurses would recommend to patients.</p>	<p>A systematic literature review was conducted in the CINAHL, Medline, ProQuest, COBIB.SI and the Cochrane Library databases. Using CASP quality appraisal tools, 18 references were selected. Six randomized clinical trials, five cohort studies, six systematic reviews and one critical review were published between 1992 and 2015.</p>	<p>As none of the techniques proved to be optimal for all patients, it is important that a healthcare professional enables the patient to make an informed choice when selecting the best method and product for their individual needs. Due to the lack of evidence and in accordance with the Slovenian chronic patients' rights, the recommended technique should include sterile disposable material (catheter and lubricant), periurethral area hygiene with sterile swabs and solution, and a no-touch technique.</p>
<p>[27] UK, France, Netherlands Literature review and cohort study</p>	<p>To identify and investigate the benefits of intermittent self-catheterization devices and further explore the readiness to pay for the quality of devices in the United Kingdom of Great Britain, France and the Netherlands.</p>	<p>283 patients replied to the questionnaire. Inclusion criteria were: at least 12 months post-injury, used intermittent self-catheterization as their main method of bladder management, did not frequently use a catheter set, had used intermittent self-catheterization for at least six months, were aged between 18 and 85 years, had access to the internet, and were currently a resident in the UK, France or the Netherlands.</p>	<p>Patients who perform intermittent catheterization evaluate as favourable and suitable catheters that are the right size, easy to insert, and those that reduce the risk of infection. It has been found that coated catheters are most desirable in all countries. The costs that patients have to settle out of their own pocket play an important role in their choice of catheter selection.</p>
<p>[21] Systematic literature review (Cochrane review)</p>	<p>To determine whether the form and material of the catheter and the technique and other characteristics of the catheterization process are associated with the formation of the urinary tract infections, other complications, and the satisfaction with and effectiveness of intermittent catheterization.</p>	<p>599 studies were found, of which 31 were analysed with a total of 1,737 people under investigation. These included 13 randomized control trials and 18 cross-sectional studies.</p>	<p>There is no evidence to link the frequency of urinary tract infections with a clean or aseptic self-catheterization technique with a coated or uncoated catheter or catheter for reuse or single use, or self-catheterization and catheterization by another person. Evidence from research is not convincing.</p>
<p>Rasool et al., 2016, Pakistan Quantitative study, randomized clinical trial</p>	<p>To compare the stricture recurrence after optical internal urethrotomy with and without clean intermittent self-catheterization in patients with urethral stricture.</p>	<p>Patient aged 20 - 60 years with urethral stricture of up to 1.5 cm and up to six months duration were included. The total number was 120 patients. They were randomly divided into two groups. In the first treatment group optical internal urethrotomy was done with clean intermittent self-catheterization, in the control group optical internal urethrotomy was done without clean intermittent self-catheterization.</p>	<p>There is a lower stricture recurrence rate after optical internal urethrotomy with clean intermittent self-catheterization in urethral stricture treatment.</p>
<p>[10] UK and France Quantitative cohort study</p>	<p>To get information on the proportion of specialist nurses using Tiemann tip catheters in hospital and community settings, factors that influenced the decision on whether to use a Tiemann tip catheter, knowledge of medical conditions better suited to the use of a Tiemann tip catheter, reasons for not using Tiemann tip catheters, ease of use for Tiemann tip catheters, education/training in the use of Tiemann tip catheters.</p>	<p>Of the 200 questionnaires distributed to the urology/continence nurse specialists, 189 were completed. 78% came from hospital-based nurses, 17% from those based in the community and 5% from those who worked in both settings.</p>	<p>It seems evident that most nurses would reach for the more commonly used Nelaton catheter before trying another type, despite understanding the benefits of using Tiemann tip catheters. This survey highlighted the need for better education for nurses and doctors in assessing the alternative catheter tips available to ensure successful catheterization on first attempt.</p>



[20] Systematic literature review and meta-analyses	To compare hydrophilic coated and PVC catheters for intermittent catheterization.	A total of 561 studies were found through PUBMED (197), EMBASE (19), Web of Science (202) and Cochrane (143). Only seven articles were found to be suitable for the study.	The findings confirm previously reported benefits of hydrophilic catheters, but an extended assessment that also takes into account patient preferences, compliance with therapy, quality of life and costs would be needed to assess the economic sustainability of these advanced devices.
[18] Systematic literature review and meta-analysis	To perform a systematic literature review on the most appropriate material and technique to perform intermittent self-catheterization in the adult neurogenic population.	After screening 3,768 articles, 31 were included in the final synthesis.	Hydrophilic-coated catheters tended to decrease the incidence of urinary tract infection, urethral trauma and improve patient satisfaction when compared with non-coated catheters. Sterile technique decrease the incidence of recurrent urinary tract infection, but the costs are significantly higher.
Shaw et al., 2007, UK Qualitative cohort study	To describe the experience of patients carrying out clean intermittent self-catheterization and the impact on their quality of life.	15 patients (eight men and seven women) using intermittent self-catheterization took part in interviews. Ages ranged from 33 to 81 years (median 65 years). Reasons for self-catheterization included multiple sclerosis, urethral stricture and high residual volumes. Thematic analysis was used to develop hypotheses about the causes and consequences of the core category 'quality of life'.	The core category consisted of two subcategories of positive and negative impacts. Positive impacts were related to improvement in lower urinary tract symptoms, whereas the negative impacts resulted from the practical difficulties encountered, and the psychological and cultural context of worry and stigma. The factors influencing variations in quality of life impacts were sex, lifestyle, frequency and duration of carrying out self-catheterization, technical difficulties, type of catheter, co-morbidities and individual predispositions.
[35] USA Quantitative prospective randomized control clinical study	To determine whether the previous application of lidocaine reduces urethral pain associated with catheterization and injection.	There were 36 adult male patients with an average age of 62 years who need intermittent catheterization. In the experimental group, patients injected 2% of lidocaine into the urethra, and in the control group, they used just a usual lubricant. After catheterization, a pain assessment with a visual analogue scale was carried out.	The use of lidocaine gel compared to the use of a usual lubricant reduces pain associated with male catheterization.
[23] Romania Quantitative cohort study	To objectively assess whether there are some important differences in specific key biological and psychometric parameters associated with the use of hydrophilic catheters compared with non-hydrophilic catheters.	45 patients with neurogenic bladder with urine retention were included. 30 patients after spinal cord injury used hydrophilic catheters, and 10 non-hydrophilic ones. Five used a non-hydrophilic catheter at the start of performing the procedure, and from 2008 onwards they used a hydrophilic one.	Patients who used a hydrophilic catheter, compared to those using a non-hydrophilic catheter, had significantly less inflammation in the area of the bladder, bleeding during and after the procedure, had extremely few urinary tract infections and expressed a high level of satisfaction.
[34] Literature review Netherlands	To identify the necessary characteristics that lubricants must have and their effectiveness, and give evidence-based guidelines for practice.	27 articles were analysed, of which 13 were linked to cystoscopy, four to catheterization, and 10 to the effectiveness of local anaesthesia.	Because of the weakness of evidence-based data, the use of lubricants is left to professionals. The review highlights the risk of long-term and frequent use of local anaesthetics in large quantities, because they could be absorbed into the mucous membrane and affect the central nervous system.

Van Achterberg et al., 2008 Netherlands Qualitative cohort prospective study	To investigate factors that hinder or promote adherence to clean intermittent self-catheterization in adults.	10 patients were included and put in two groups, over the age of 65 and younger patients.	Most of the determinants were found in both older and younger patients. Five determinants of mastery and short-term adherence and six determinants of long-term adherence were specific to patients under the age of 65. In younger patients, the availability of materials, physical impairments and resistance to a sickness role can further compromise adherence.
Zambon et al., 2009 Literature review	Analyse the advantages and disadvantages of clean intermittent catheterization, compared to an indwelling urinary catheter, in the treatment of chronic urinary retention.	25 papers were selected, including three meta-analyses evaluating the long-term complications of clean intermittent catheterization, prophylactic intervention, and catheter types. Most articles discussed complications in patients with neurologic dysfunctions.	Clean intermittent catheterization is associated with lower complication rates, both short- and long-term, and thus is better than indwelling catheterization. Indwelling catheterization was associated with decreased vesical compliance and bladder calculi.
[37] Literature review	To describe the patients' quality of life, satisfaction, clean intermittent self-catheterization, indicators for performing the procedure, factors influencing patient suitability to perform the procedure, advantages and disadvantages of the procedure, perceptions of the procedure and effects on compliance.	Review of published literature about the physical and clinical advantages and disadvantages related to carrying out the procedure, patient satisfaction and quality of life.	There is much unconfirmed evidence and a lack of research on the effects of clean intermittent self-catheterization on quality of life.
Wyndaele et al., 2000, Belgium Quantitative prospective cohort study	To determine if the Uroath-Gel catheter is well accepted and evaluate their use in practice.	39 male patients, aged 19 to 74 years of age who performed clean intermittent self-catheterization with conventional catheters for several years were included in the study.	The Uroath-Gel hydrophilic catheter proved to be easy to use, just like a conventional catheter, but it was more acceptable. The satisfaction was better, especially in patients who had problems with the conventional catheter. However, some patients were not satisfied for economic and practical reasons.
[28] Literature review	To determine whether there exists the best technique of intermittent catheterization and intermittent self-catheterization.	Review of 64 articles.	There are many types of materials and techniques applied for intermittent catheterization and intermittent self-catheterization. But these do not change the outcome if the basic principles are followed: good education and training, use of proper material and technique, frequent catheterization and avoiding an overfilled bladder.

**Table 3:** Codes by categories and authors.

Categories (n = 4)	Codes (n = 33)	Author (n = 41)
Urinary tract infections	Risks - trauma - irritation - bleeding - coated catheter - uncoated catheter - bacteriuria - hydrophilic catheter - non-hydrophilic catheter - PVC catheter	[17,19,28,2,22,23,8,20,16] Shamout et al., 2013; Mistry et al., 2007
Duration of catheter use	Home environment - single-use catheter - reuse catheter - long-term use - catheter cleaning - costs	[18,26,24,25,28,8,38,27]
Catheterization technique	Guidelines - hospital care - aseptic technique - clean technique - non-touch technique - meatal cleaning safety - gadgets	[17,29, 30,21,40,36,34,35,31] Denys et al., 2013;
Patients' satisfaction	Quality of life - learning - independence - daily activities - gender - comfort - pain -catheter selection - packing	[30,6,17,37,33,32,19,27,18,23,39,22,38] Nnabugwu et al., 2014; Kriz & Relichova, 2014; James et al., 2014; Shaw et al., 2007; Lubahn et al., 2014

## Discussion

A dominant symptom in patients performing intermittent self-catheterization is the catheter-associated urinary tract infection [7]. However, the risk of urinary tract infection is lower in intermittent catheterization than with indwelling catheters [16]. Some studies, like Bermingham et al. [17], Shamout et al. [18] show, that the type of catheter cannot be a cause of increased risk for infection. But, at the opposite, De Ridder et al. [19] found that urinary tract infections happened to 64 % of patients using a hydrophilic catheter comparing to 82 % of patients who used uncoated PVC catheters. Many authors [17,20] conclude, that there is a difference in the incidence of urinary tract infection related to the catheter material, but it is not statistically significant. Also, a Cochrane review [21] revealed that there is no valuable evidence to link the frequency of urinary tract infections with a coated or uncoated catheter. Catheterization is certainly a mild but also unnatural activity which cannot be explained just from the catheter issues, but have to be concerned also about technique, and other supplements used. The main difference in catheters for self-catheterization concerns coated and non-coated catheters. It is known that coated catheters tend to be more comfortable and cause less urethral trauma than non-coated catheters [2]. Authors also agree [22,23], that the coated hydrophilic catheters reduce the irritation and bleeding during and after the procedure.

Another issue is the catheters' period of use. Hydrophilic catheters can be used just once, but the uncoated catheters many times. The literature findings are inconsistent. Authors describe that PVC catheters are used at least 2 to 200 times [24], from 2 to 4 weeks [25], or on average 35 months in less developed countries [26]. The costs that patients have to pay for themselves play an important role in the timing of use and selection of catheters [27]. There are studies [18,26,28] claiming that the period of catheters' use, is associated with the incidence of urinary tract infections. But the Cochrane review shows that there is no evidence to link the frequency of urinary tract infections with a catheter for reuse or single use [21]. The studies are inconsistent again, the incidence of urinary tract infections is not significantly related to the period of using the same catheter.

Also, when thinking about re-use catheters, we must include the manner of taking care of the catheter. There is no reliable evidence on the method of cleaning catheters for reuse, but in practice, patients rinse the catheter under running water using soap, chemically disinfect it or microwave it [25]. Kovindha et al. [26] recommend the disinfection of the catheter by soaking it in a 1: 100 solution of savlon (chlorhexidine 1.5 % and cetrimide 15 %), and then rinsing the lumen well under running water to prevent lining formation. Disinfection of the catheter with microwaves, with chlorhexidine or with iodine is not advised. As well as boiling, because it can causes damages to the catheter tip [26]. Microwaving the catheter up to 12 minutes is not sufficient to eradicate *Pseudomonas aeruginosa* or *Staphylococcus*

*aureus*, although there is minimal change to its' physical qualities [24]. According to differences in described cleaning methods we cannot suggest a reliable manner of taking care of the re-use catheters.

Self-catheterization should be done with an aseptic technique in the hospital care, but a non-touching clean technique in a home environment [4,25,29,30]. The aseptic technique did not prove to be safer compared to clean [18]. Peršolja [31] wrote that until it is possible to develop guidelines for intermittent self-catheterization in the home environment based on scientific evidence, only the use of sterile catheters is safe for patients that use the non-touching technique. Considering vague evidence, we therefore could suggest the non-touching clean technique, which involves working with or without gloves, a non-sterile solution for meatal cleaning, the single or multiple-use catheter, and lubricants [25]. Comfort catheterization is affected by different selection criteria: catheter size, type, and material [32], ease in handling, and the onset of pain due to the adhesion of the catheter to the mucous membrane [33]. Patients who perform intermittent self-catheterization consider as an appropriate catheter the one that is the right size, easy to insert, and that reduces the risk of infection. Coated catheters were found to be the most desirable [27]. Tzortzis et al. [34] and Siderias et al. [35] did not find sufficient evidence to recommend the use of a lubricant or the anesthetic. As the literature is not clear what it is better for the patient, we have to consider nursing guidelines. Therefore, we can suggest, that the anesthetic should be applied in a sufficient amount (6 ml for women and 11 ml for men) at least five minutes before catheterization to take effect [35].

An important part of the procedure is also meatal cleaning. According to the study of Cunha et al. [36], the use of antiseptic and anti-microbial solutions for disinfection of the urinary meatus does not reduce the risk of urinary tract infection. Water, saline, or antiseptics are equally effective in cleaning or disinfecting the meatus.

Considering patient satisfaction, catheters with hydrophilic coating significantly reduce irritation of the urethra and increase patient satisfaction [17,18,37]. Patients also report that single-use catheters make catheterization away from home easier [38]. Logan [32], for example, has found that for the packing of the hydrophilic catheter is important to be silent to open. This is very important when performing intermittent self-catheterization in public toilets. But the opponents of hydrophilic catheters, mention handling problems resulting from a slippage of catheter surface [22,39]. Although there is insufficient evidence to indicate whether hydrophilic catheters are associated with improved patient satisfaction [40]. Bermingham et al. [17] suggested that patients should be offered a choice between reuse and single-use and different catheter types. Because, one product is unlikely to suit everyone, and intermittent catheterization users require products that meet their individual preferences and needs [38].

Self-catheterization requires motor, sensory, and visual abilities, coordination, effective movement, and care for cleanliness from the patient. Patients performing long-term intermittent self-catheterization need the involvement of nursing staff in equipment choice. The findings of this review underscore the shared responsibility of health care professionals and patients. Concerns about the safety and reliability of equipment need to be acknowledged and overcome. Due to inconsistent terminology, different living standards, and thus access to different materials and tools, scientific evidence does not reduce uncertainty in practice. This review highlights the need for further research that employs rigorous study designs using valid and reliable instruments. The analyzed studies are difficult to discuss in terms of the diversity of the selected environment (rehabilitation centers, home environment, long-term care centers, hospitals), patient groups (by gender, degree of disability, duration of intermittent catheterization, antibiotic prevention), self-catheterization provider (medical staff, relatives, patient), patient abilities (sensory, motor, educational, material).

Therefore, it is necessary to define the details of atraumatic catheter insertion: long-term and comprehensive importance of choosing a sterile or non-sterile catheter, a time frame of repeated catheter use, to give guidelines for catheter care, justify the choice of moisturizing gel, its quantity, clean or sterile technique, potential risks with multiple daily long-term uses of lidocaine, choice of material for periurethral hygiene. There is also a need for experimental studies on catheter selection using artificial genitalia. Our study has several limitations. This review only included papers in English and Slovene. The research design used in the studies affected the quality of evidence. Studies from different countries have been included, among which the rights to health accessories vary. With this literature review, we were not able to find reliable evidence to support the choice of an optimal catheter.

### Conclusion

The main finding of this study is that there is a lack of scientific evidence to support the choice of a particular catheter for intermittent (self-)catheterization in advance. Clinical evidence is insufficient for powerful decision-making. There is no reliable evidence that any technique of self-catheterization is prior to others concerning urinary tract infection incidence, and they, therefore, suggest to use the cheaper technique – the clean method, with reuse (non-sterile) catheters where the timing of use and neither the assessment of catheter are defined, and all gadgets used for catheterization are clean but non sterile. On the other hand, many studies support the use of hydrophilic catheters to reduce urethral trauma, but the evidence is insufficient to indicate whether these catheters are associated with improved patient satisfaction and less urethral infections. It is shore however, that hydrophilic catheters are the most preferred from patients.

Though we were unable to find enough evidence supporting

the selection of an optimal catheter, the results tend to propose the single-use of hydrophilic catheters to reduce urethral trauma and the non-touching technique with sterile equipment to lower infections incidence. The selection of the catheter should depend primarily on the: a.) patients' preference (of the catheter type, material, catheterization technique), anatomy, and hands functionality; b.) catheter availability and ease of use. It is recommended that nurses together, with the patient, firstly select the technique of self-catheterization, try it, and only after that select the optimal catheter.

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