



PRACTICE

PRACTICE POINTER

Managing long term indwelling urinary catheters

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What you need to know

- Before considering a long term catheter, explore alternatives such as pads, sheaths, collection devices, and intermittent catheters.
- Leakage, blockage, and infection with catheters are to be expected.
- Suprapubic catheters may suit patients for whom sexual function is important.
- Valves reduce the inconvenience of a bag and may be linked to fewer infections.
- If an infection is suspected, replace the catheter before taking a urine specimen to reduce contamination.

Around in 90 000 people in the UK live with a long term catheter (one that has been in place for four weeks or more).¹ Use of catheters varies considerably, suggesting differences in how or whether they are used. For example, in a study of more than 4000 people aged over 65 receiving domiciliary care in 11 European countries, long term catheter use ranged from 0% (Netherlands) to 23% (Italy).²

Problems with long term catheters, such as infections or blockage, affect individuals' lives and healthcare resources, particularly out-of-hours services.³ This article aims to help healthcare professionals address the needs of any person living with or making the decision to have a long term indwelling urinary catheter (examples shown in [fig 1](#)).

When are long term catheters used and what are the alternatives?

Urinary retention and urinary incontinence are the two main indications for long term catheters. An algorithm providing an overview of the process for deciding between a long term indwelling catheter and an alternative management options ([box 1](#)), is shown in [figure 2](#).⁴⁻⁸ Discussion about urinary problems and management options can involve a range of healthcare professionals, including those in primary, community, or secondary care, physicians, and nurses.

Box 1: Commonly used non-invasive incontinence management

Absorbent pads are the most common. They are available in a range of disposable and reusable designs. Choice depends on sex, level, and type of incontinence, and functional ability (eg, ability to stand to change product)

Male devices include urinary sheaths ("condom" catheters) and body worn urinals. Sheaths come in different sizes and styles and should be fitted by a trained professional. Body worn urinals may be worn with a collection bag or valve

Bedside commodes can be used by people who can safely transfer, but are unable to reach a conventional toilet

Handheld urinals (reusable and disposable) are available in male and female designs and can be used sitting or lying

Bedpans are more commonly used in hospital or residential settings, but some women might prefer a bedpan if handheld urinals do not work well for them.

For detailed guidance on the wide range of containment products and their pros and cons, see the link to the Continence Product Advisor website ([box Further resources](#)).

There is little evidence to support the use of a long term catheter over other bladder management options. For some people, however, other methods are unsuccessful or unacceptable and a catheter can improve quality of life. [Table 1](#) shows some of the problems associated with indwelling catheters. [Box 2](#) gives ideas of the pros and cons of catheters that can be discussed with patients.

Box 2: Weighing up the benefits and harms of catheters in general**Examples of positive impact**^{18 25-28}

- Reduces anxiety about incontinence
- Facilitates work, sports, travel, or social life
- Aids sleep
- Reduces frequency of painful or disruptive pad changes
- Increases independence or lessens reliance on carers
- Suprapubic facilitates sex

Examples of negative impact^{18 25-28}

- Infections and other complications
- Anxiety over unpredictability of catheter problems (eg, sudden blockage)
- Difficult to manage away from home (eg, taking equipment on holiday)
- Sense of physical restraint
- May want to hide equipment
- Limits clothing choices (eg, shorts or fitted skirts)
- Interrupts sleep due to discomfort or pulling
- Causes embarrassment around catheter changes
- Changes self identity (eg, feeling "unclean" or not feminine/masculine)
- Restricts sexual activity

Urinary retention

The need for long term catheterisation (indwelling or intermittent) to manage post-void residual volume is not always clear, but should be directed by patient symptoms (eg, incontinence, infection, risk of renal dysfunction, or discomfort). There can be a fine balance between the harm of undertreating potentially damaging retention and overusing urinary catheters to treat asymptomatic post-void residual volume, particularly with older people.²⁹

If possible, intermittent catheterisation is a better option than an indwelling catheter because there are fewer harms.

Intermittent catheters can reduce complications and promote quality of life compared with indwelling urinary catheters.³⁰ Do not assume that older people lack the cognitive or physical function to implement a regimen of self catheterisation, as these assumptions are often unfounded.³¹

Urinary incontinence

Try other management strategies before resorting to catheterisation (box 1). Indwelling urinary catheters are not the first line of management for intractable urinary incontinence. There is a wide range of disposable or reusable unisex, male and female absorbent pads. Men can also try urinary sheaths and collection devices. Most people with incontinence rely on absorbent pads or male devices. Seek advice from a continence nurse specialist where possible.

For each patient, key factors such as personal values, functional ability, and context of care guide the choice of continence management product or combination of products.

Catheters should not be used to manage incontinence associated dermatitis; this condition should instead be prevented or managed using structured skin care. A catheter can be considered to manage existing perineal or sacral open skin wounds that become contaminated by urine,^{4 7 8} but it should be removed when wounds are healed.

Box 2 offers an overview of potentially positive and negative effects of using a long term indwelling catheter, and suggests questions that can help decide whether to insert a long term catheter.

What are the common catheter problems and management strategies?

Long term catheters are associated with substantial morbidity. Common complaints and complications associated with long term catheters are discussed in boxes 2 and 3 and table 1, including clinical pointers on management based on expert opinion. Daily management of these problems is generally undertaken by community nurses, with input from general practitioners or secondary care for UTI or blockage that occurs out of hours. Discuss with patients and carers the sources of local support and information available should problems arise.

Box 3: Questions to assess catheter related quality of life for current catheter users (from the ICIQ Long-term Catheter Quality of Life tool²²)

- Do you have confidence in your catheter equipment?
- Is the possibility of catheter leaking on your mind?
- Is the possibility of catheter blocking on your mind?
- How problematic is your catheter?
- How often do you have "urine infections" that make you feel unwell or require you to take antibiotics?
- Does your catheter cause you to worry about smell?
- Are you embarrassed by having a catheter?
- Do you feel you have adapted to a life with a catheter?
- Overall, how much does having a catheter affect your everyday life?
- Does your catheter affect your ability to travel?
- Does your catheter affect your social activities?
- Does your catheter affect your ability to go out of the house?
- Do you use pads as well as your catheter because of your bladder?
- Does your catheter cause any pain, discomfort, or soreness?
- Do you experience any bladder spasm?
- Does having a catheter affect your sexual activity?

There is limited evidence to support the relative merits of different long term catheter management strategies and long term catheter care regimens, including the use of bladder washout,¹⁹ protocols for catheter change frequency,³³ and the use of different catheter materials.¹² Some strategies, although lacking evidence, appear to offer common sense advantages—for example, carefully securing catheter, tubing, and collection bag to avoid trauma and pain, and the use of a valve (fig 3), which removes the need for a collection bag.

Which catheter and drainage solution to choose

Once patient and clinician have decided to place a catheter, there are two further key decisions: catheter type (urethral or suprapubic, including location of suprapubic stoma) and method of drainage (either a manual valve—used with or without a collection bag—that is opened as required to drain urine then closed, or continuous drainage from the bladder into a collection bag). Catheters are generally changed every 1-3 months, although evidence to support a particular frequency for changing is lacking.

Catheter type

There is no evidence to support the superiority of either suprapubic or urethral catheters to minimise the risk of UTI¹⁵ or improve quality of life,³⁴ and the advantages and risks need to be considered for each patient.³⁵ Suprapubic catheters reduce risk of urethral trauma,³⁶ are easier to drain, and give greater freedom for sexual activity.⁶ But they typically need inserting

by a specialist (urologist), and there is the potential for bowel laceration with surgical insertion.³⁷

Method of drainage

A catheter valve gives the patient the option of having no collection bag; which avoids the bulkiness and visibility of tubing and bags.¹⁸ Laboratory studies have additionally shown that valve use can increase time to catheter blockage,³⁸ but clinical evidence is lacking and the devices are not suitable for all patients (box 4).

Box 4: Key factors to discuss with patients when making decisions regarding long term indwelling urinary catheters

Type of catheter: Urethral or suprapubic (if both options are clinically appropriate)

- Activities influencing catheter placement and potential locations for a suprapubic catheter (consider clothing, sex, sport, other healthcare devices or equipment)

Method of urine collection: Valve or drainage bag (or both)

- Functional ability required for self managing a valve (including dexterity, flexibility, cognitive awareness of bladder fullness)
- Carer management of a valve (including patient's awareness of bladder fullness and ability to communicate, accessibility of valve)

How to manage a catheter: Checking the patient's understanding of How to get catheter supplies

How and when to change the valve/drainage bag

When the catheter should be changed

What to do with catheter tubing at night

How to safely position and secure the catheter and valve/drainage bag

How to recognise signs of infection

What to do if there is reduced drainage

Who to contact in case of emergency (blockage or displacement) and what to do

What is an urgent problem and what can wait

Supporting patient information

Patients often report a lack of knowledge or support with managing and making day-to-day decisions about their catheters.³⁹ Box 4 provides a summary of the practicalities of living with a catheter that can be discussed with new users.

Further resources

- www.continenceproductadvisor.org A website developed through a joint initiative between International Consultation on Incontinence and the International Continence Society that provides evidence based, independent advice on continence products
- www.nhs.uk/Conditions/Urinary-catheterization/Pages/living-with-NHS-advice-on-living-with-a-catheter
- www.baus.org.uk/userfiles/pages/files/Patients/Leaflets/Catheter.pdf Guidance on management of a urethral catheter
- www.healthtalk.org/ People's real life experiences of living with a urinary catheter
- www.icq.net/ICIQ-LTCqol.html ICIQ questionnaire on quality of life with a long term catheter

Education into practice

- Are you aware of local referral pathways to get advice or support from a continence nurse specialist?
- What resources are available to help guide discussion and decision making with a patient about the potential placement of a long term catheter?
- What will you do differently as a result of reading this article?

How this article was produced

We performed a PubMed search using the terms "urinary catheter" AND "management" OR "problems" OR "strategies." We examined Cochrane and other relevant systematic reviews. We supplemented these with additional searches and our knowledge of the subject.

How patients were involved in the creation of this article

Co-author AC is a long term user of catheters and an active patient representative. She has been a co-investigator on clinical trials, and has been a panel member at conferences, speaking on catheter use. She emphasised the need to highlight quality of life issues (the pros and cons of catheters) and the practicalities of living with a catheter. Subsequently, both breadth and depth of coverage of these topics was increased.

We have read and understood BMJ policy on declaration of interests and declare that we have no competing interests.

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- 1 Gage H, Avery M, Flannery C, Williams P, Fader M. Community prevalence of long-term urinary catheters use in England. *NeuroUrol Urodyn* 2017;36:293-6. 10.1002/nau.22961 26878267
- 2 Sørbye LW, Finne-Soveri H, Ljunggren G, Topinková E, Bernabei R. Indwelling catheter use in home care: elderly, aged 65+, in 11 different countries in Europe. *Age Ageing* 2005;34:377-81. 10.1093/ageing/afi094 15901577
- 3 Tay LJ, Lyons H, Karrouze I, Taylor C, Khan AA, Thompson PM. Impact of the lack of community urinary catheter care services on the Emergency Department. *BJU Int* 2016;118:327-34. 10.1111/bju.13430 26917016
- 4 Gould C, Umscheid C, Agarwal R, et al. Healthcare Infection Control Practices Advisory Committee guideline for prevention of catheter-associated urinary tract infections. *Infect Control Hosp Epidemiol* 2010;31:319-26. 10.1086/651091 20156062
- 5 Cottenden A. Management using continence products. In: Abrams P, Cardozo L, Khoury S, Wein A, eds. *Incontinence*. 5th ed. ICUD ICS, 2013: 1651-786.
- 6 Royal College of Nursing. Catheter care—RCN guidance for nurses. 2012. <https://www.rcn.org.uk/professional-development/publications/pub-003237>
- 7 National Institute for Health and Care Excellence. Lower urinary tract symptoms in men: management (NICE Guideline CG97) 2010. <https://www.nice.org.uk/guidance/cg97>
- 8 National Institute for Health and Care Excellence. Urinary incontinence in women: management (NICE Guideline CG171) 2013. <https://www.nice.org.uk/guidance/cg171>
- 9 Wilde MH, McDonald MV, Brasch J, et al. Long-term urinary catheter users self-care practices and problems. *J Clin Nurs* 2013;22:356-67. 10.1111/jocn.12042 23301577
- 10 Nicolle LE. Catheter associated urinary tract infections. *Antimicrob Resist Infect Control* 2014;3:23. 10.1186/2047-2994-3-23 25075308
- 11 Cottenden A, Fader M. Management using continence products. In: Abrams P, Cardozo L, Wagg A, Wein A, eds. *Incontinence*. 6th ed. ICUD ICS, 2017: 2303-426.
- 12 Pickard R, Lam T, MacLennan G, et al. Types of urethral catheter for reducing symptomatic urinary tract infections in hospitalised adults requiring short-term catheterisation: multicentre randomised controlled trial and economic evaluation of antimicrobial- and antiseptic-impregnated urethral catheters (the CATHETER trial). *Health Technol Assess* 2012;16:1-197. 10.3310/hta16470 23199586
- 13 Lam TB, Omar MI, Fisher E, Gillies K, MacLennan S. Types of indwelling urethral catheters for short-term catheterisation in hospitalised adults. *Cochrane Database Syst Rev* 2014;23:CD004013.25248140
- 14 Wilde MH, Crean HF, McMahon JM, et al. Testing a model of self-management of fluid intake in community-residing long-term indwelling urinary catheter users. *Nurs Res* 2016;65:97-106. 10.1097/NNR.000000000000140 26938358
- 15 Niël-Weise BS, van den Broek PJ, da Silva EM, Silva LA. Urinary catheter policies for long-term bladder drainage. *Cochrane Database Syst Rev* 2012;8:CD004201.22895939
- 16 Wilks SA, Fader MJ, Keevil CW. Novel insights into the proteus mirabilis crystalline biofilm using real-time imaging. *PLoS One* 2015;10:e0141711. 10.1371/journal.pone.0141711 26516766
- 17 Hollingsworth JM, Rogers MA, Krein SL, et al. Determining the noninfectious complications of indwelling urethral catheters: a systematic review and meta-analysis. *Ann Intern Med* 2013;159:401-10. 10.7326/0003-4819-159-6-201309170-00006 24042368
- 18 Fowler S, Godfrey H, Fader M, Timoney AG, Long A. Living with a long-term, indwelling urinary catheter: catheter users' experience. *J Wound Ostomy Continence Nurs* 2014;41:597-603. 10.1097/WON.000000000000069 25198153
- 19 Shepherd AJ, Mackay WG, Hagen S. Washout policies in long-term indwelling urinary catheterisation in adults. *Cochrane Database Syst Rev* 2017;3:CD004012.28262925
- 20 Getliffe K. Managing recurrent urinary catheter blockage: problems, promises, and practicalities. *J Wound Ostomy Continence Nurs* 2003;30:146-51. 12761486
- 21 Fisher J. The importance of effective catheter securement. *Br J Nurs* 2010;19:S14-8. 10.12968/bjon.2010.19.Sup8.79064 20948482
- 22 Ho CH, Sung KC, Lim SW, et al. Chronic indwelling urinary catheters increase the risk of bladder cancer, even in patients without spinal cord injury. *Medicine (Baltimore)* 2015;94:e1736. 10.1097/MD.0000000000001736 26512566
- 23 Gao Y, Danforth T, Ginsberg DA. Urologic management and complications in spinal cord injury patients: a 40- to 50-year follow-up study. *Urology* 2017;104:52-8. 10.1016/j.urol.2017.03.006 28322903
- 24 Lwaleed B, Tan X, Tudball T, et al. The role of bladder filling and voiding in maintaining bladder health: urinary and plasma cytokines in catheterised patients using valves or on free drainage. In *Int Continence Soc Conf*, Toyo Japan 13-16 October 2016, paper no 565. Bristol: ICS.

- 25 Chapple A, Prinjha S, Feneley R, Ziebland S. Drawing on accounts of long-term urinary catheter use: design for the "seemingly mundane.". *Qual Health Res* 2016;26:154-63. 10.1177/1049732315570135 25646001
- 26 Chapple A, Prinjha S, Salisbury H. How users of indwelling urinary catheters talk about sex and sexuality: a qualitative study. *Br J Gen Pract* 2014;64:e364-71. 10.3399/bjgp14X680149 24868074
- 27 Godfrey H. Living with a long-term urinary catheter: older people's experiences. *J Adv Nurs* 2008;62:180-90. 10.1111/j.1365-2648.2007.04584.x 18394030
- 28 Wilde MH. Life with an indwelling urinary catheter: the dialectic of stigma and acceptance. *Qual Health Res* 2003;13:1189-204. 10.1177/1049732303257115 14606409
- 29 Ostaskiewicz J. Incomplete bladder emptying in frail older adults: A clinical conundrum. *Int J Urol Nurs* 2007;1:87-91. 10.1111/j.1749-771X.2007.00019.x
- 30 Yasami S, Khadem M, Safaei G, Latifi S, Koushki D, Yazdanshenas Ghazwin M. The association between bladder-emptying methods and health-related quality of life among Iranian individuals with spinal cord injury. *J Spinal Cord Med* 2017;40:530-7. 10.1080/10790268.2016.1173320 27104684
- 31 Parsons BA, Narshi A, Drake MJ. Success rates for learning intermittent self-catheterisation according to age and gender. *Int Urol Nephrol* 2012;44:1127-31. 10.1007/s11255-012-0136-x 22350836
- 32 Cotterill N, Fowler S, Avery M, et al . Development and psychometric evaluation of the ICIQ-LTCqol: A self-report quality of life questionnaire for long-term indwelling catheter users. *NeuroUrol Urodyn* 2016;35:423-8. 10.1002/nau.22729 25663120
- 33 Cooper FP, Alexander CE, Sinha S, Omar MI. Policies for replacing long-term indwelling urinary catheters in adults. *Cochrane Database Syst Rev* 2016;7:CD011115.27457774
- 34 Avery M, Cotterill N, Fowler S, Cottenden A, Fader M. Long-term urinary catheter users and quality of life. In *UK Continence Soc Conf* 2014 London.
- 35 Harrison SC, Lawrence WT, Morley R, Pearce I, Taylor J. British Association of Urological Surgeons' suprapubic catheter practice guidelines. *BJU Int* 2011;107:77-85. 10.1111/j.1464-410X.2010.09762.x 21054755
- 36 Katsumi HK, Kalisvaart JF, Ronningen LD, Hovey RM. Urethral versus suprapubic catheter: choosing the best bladder management for male spinal cord injury patients with indwelling catheters. *Spinal Cord* 2010;48:325-9. 10.1038/sc.2009.134 19823191
- 37 European Association of Urology Nurses. Catheterisation indwelling catheters in adults—urethral and suprapubic. 2012. Arnhem, Netherlands. <https://nurses.uroweb.org/guideline/catheterisation-indwelling-catheters-in-adults-urethral-and-suprapubic/>
- 38 Sabbuba NA, Stickler DJ, Long MJ, Dong Z, Short TD, Feneley RJ. Does the valve regulated release of urine from the bladder decrease encrustation and blockage of indwelling catheters by crystalline proteus mirabilis biofilms? *J Urol* 2005;173:262-6. 10.1097/01.ju.0000141139.76350.49 15592093
- 39 Prinjha S, Chapple A, Feneley R, Mangnall J. Exploring the information needs of people living with a long-term indwelling urinary catheter: a qualitative study. *J Adv Nurs* 2016;72:1335-46. 10.1111/jan.12923 26893125

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Table

Table 1 | Common long term urinary catheter problems and management strategies

Problem	How common	Strategies and evidence	Clinical pointers based on evidence and expert opinion
<p>Infection: Symptomatic urinary tract infections (UTIs). Acquisition of bacteriuria potentially leading to chronic infection</p>	<p>Prevalence of infection varies but one study showed that around a third of long term catheter users had a UTI in a two month period.⁹ The daily risk of acquisition of bacteriuria with an indwelling urinary catheter is 3-7%, with all users having bacteriuria after 1 month¹⁰</p>	<p>Catheter materials to reduce risk of infection: Silicone elastomer coated latex, hydrophilic polymer coated latex, and all silicone.¹¹ These materials can be treated (eg, silver coatings or antibiotic impregnation), but no material or treatment has been found to make a clinically significant reduction in symptomatic infection.^{12,13} Self management strategies: It is not clear which strategies are most effective. An intervention to promote self management focusing on fluid intake (common advice) did not reduce episodes of infection or decrease blockage.¹⁴ Catheter change strategies: There is insufficient evidence to support any particular frequency for changing catheters (generally 1-3 months) because outcomes, including rate of infection, trauma, patient satisfaction, or cost effectiveness, are not substantially different¹⁵</p>	<p>The catheter connections should be left intact so far as possible (maintaining a closed system). When symptomatic UTI occurs, remove the catheter and obtain a culture. Use a new catheter to do this to avoid culturing the biofilm and multiple organisms on the in situ catheter; treat with appropriate antibiotic. Replace the catheter OR leave it out after assessing the need for the catheter. Ensure that the catheter tubing is draining and that the drainage bag is below the level of the pubis; check that drainage tubing is straight and that there are no large loops which can impede effective drainage (also called "dependent loops")¹¹</p>
<p>Blockage: Blockage is caused by crystalline deposits that can form after four days,¹⁶ or by the bladder mucosa or debris (eg, mucous, blood clots) blocking the catheter eyes or lumen</p>	<p>Between a quarter and a half of indwelling urinary catheter users experience some level of blockage at least monthly^{9,17}</p>	<p>Catheter valve (with or without drainage bag): A manually operated valve allows the bladder to regularly fill and flush, which is widely believed but not clinically shown to maintain bladder size and reduce incidence of blockage. For most people, the use of a valve removes the need for a drainage bag and qualitative studies indicate this is likely to have a positive impact on their catheter related quality of life.¹⁸ Bladder washout for prophylactic prevention of blockage and blockage removal: Bladder washout regimens are widely implemented; however a Cochrane review¹⁹ found no evidence to conclude that they are harmful or beneficial</p>	<p>If a patient experiences regular blockage, develop an anticipatory schedule so that the catheter is changed before blockage occurs.²⁰ Treating UTI (as above) may reduce blockage. Avoid increasing the size of the catheter to facilitate drainage, as larger catheters (>16-18Fr) can cause urethral erosion and trauma¹¹</p>
<p>Leakage around the catheter (bypassing): Potential causes include bladder overactivity, blockage, or straining with bowel movements</p>	<p>Up to 40% of users experience regular leakage around the catheter⁹</p>	<p>Smaller balloons (10-15 ml) are recommended, as large catheter balloons can damage the bladder neck, making catheter retention impossible¹¹</p>	<p>If a suprapubic catheter is an option, identify this early before long term urethral catheterisation damages the bladder neck. Consider urology referral for suprapubic catheter if the patient agrees</p>
<p>Pain and trauma: Meatal or urethral trauma, blockage, or bladder spasm may cause pain during insertion, removal, or while the device is in situ.⁹ Reasons for trauma include poor lubrication of the catheter, inappropriate inflation of the balloon (eg, while in the urethra), traumatic removal of the device without deflating the balloon properly, or poor catheter or drainage bag support</p>	<p>25% of users</p>	<p>Difficult catheterisation: Persisting with attempts to catheterise or using force can cause false passage and irreparable urethral damage.¹¹ Finding the right method of support can help reduce the risk of pain and trauma²¹</p>	<p>Consult a urologist if catheterisation is difficult. If the patient experiences discomfort during catheter changes, consider use of 2% lidocaine HCl anaesthetic gel. Ensure appropriate securing of catheter and bag: straps, net support garments, and suspension belts are suitable for different needs</p>
<p>Bladder health: Using a long term indwelling urinary catheter is associated with greater risk of bladder cancer,²² bladder stones,²³ and increased bladder inflammatory markers²⁴</p>	<p>Bladder stones: 49% in a 45 year follow-up.²³ Increased risk of bladder cancer by hazard ratio of 9.11²²</p>	<p>No evidence; based on good practice</p>	<p>Regularly review catheters in situ for extended periods, and consider them for removal¹¹ (fig 2)</p>

Figures

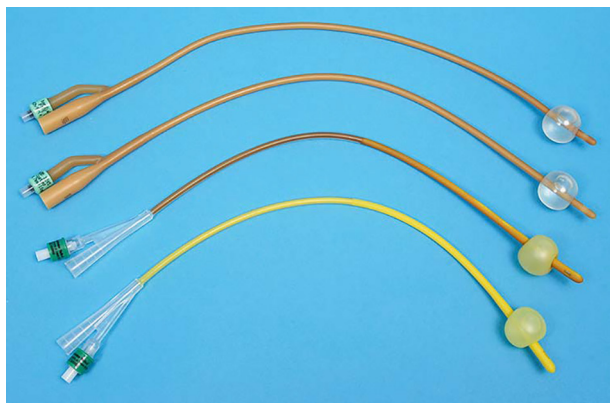


Fig 1 Examples of indwelling catheters

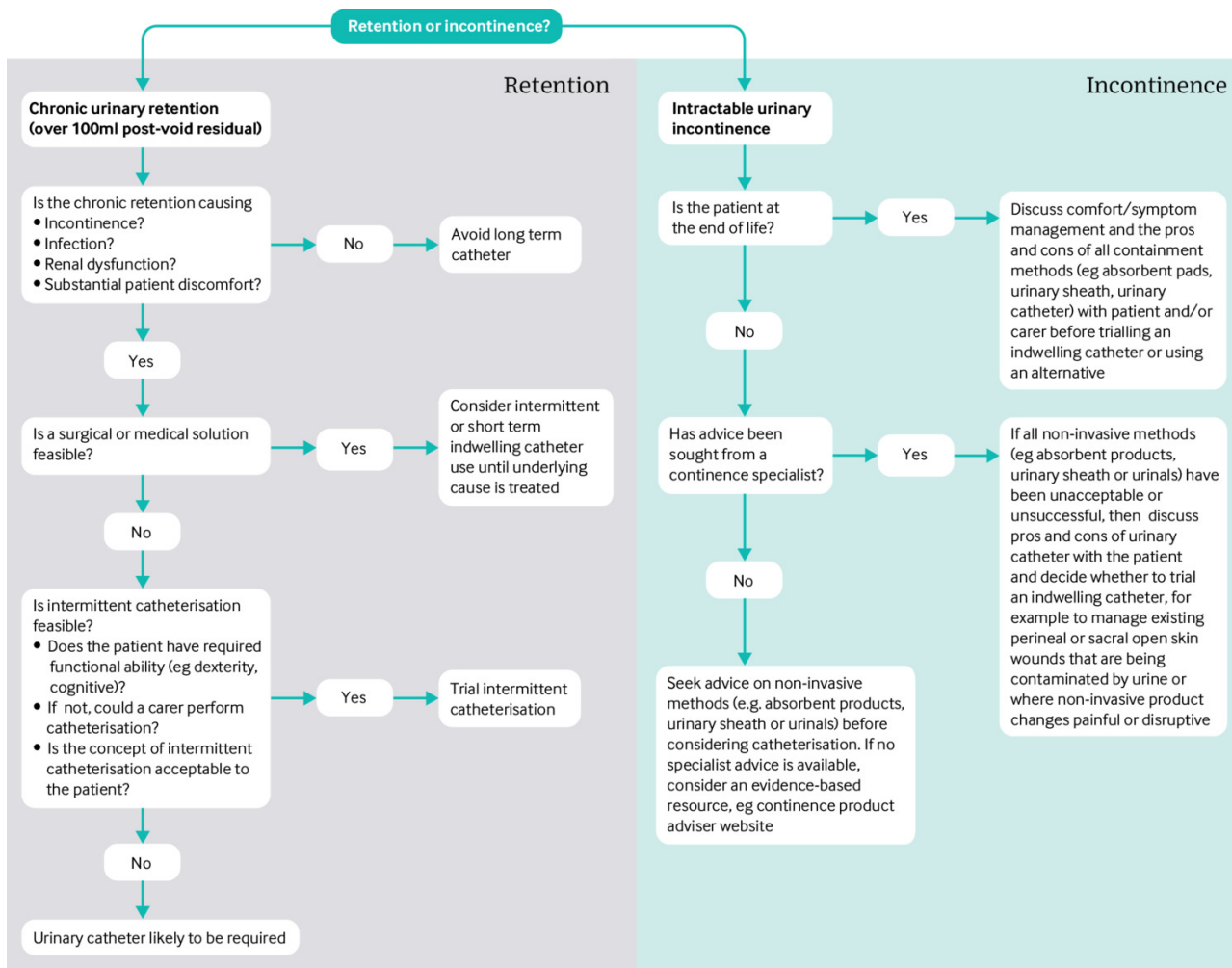


Fig 2 When is a long term indwelling catheter indicated?

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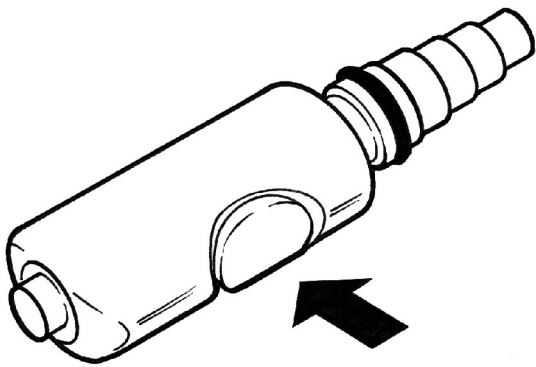


Fig 3 Button press catheter valve