Keywords Catheter/Blockage/Encrustation/Patency solution

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In this article...

- Causes of mechanical and luminal catheter blockages
- Catheter encrustation following bacterial contamination
- When and how to use catheter patency solutions

Using patency solutions to manage urinary catheter blockage

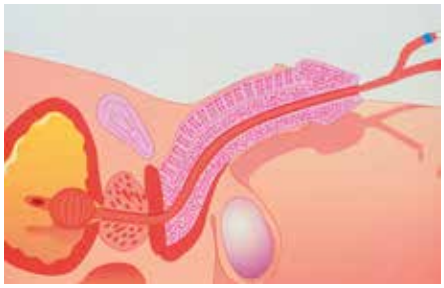
Key points

Catheter blockage can be due to a mechanical dysfunction or to occlusion of its lumen, usually by encrustation

Encrustation results from sterile acidic urine turning alkaline due to the presence of micro-organisms, which have often formed a biofilm

Catheter patency solutions can be used to maintain patency in catheters at risk of blockage

Before using a catheter patency solution, mechanical blockage must be ruled out and luminal blockage confirmed



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Author Ann Yates is director of continence services, Cardiff and Vale University Health Board.

Abstract Blockage of an indwelling urinary catheter is a frequent problem occurring mainly with long-term catheter use, which is associated with urinary tract infections. The blockage can be due to a mechanical dysfunction or occlusion of the catheter lumen; luminal obstruction is usually caused by encrustation due to bacterial contamination. This article reviews the management of blocked catheters and the use of catheter patency solutions, using expert opinion to complement the sparse evidence available in this area.

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Indwelling urinary catheterisation is a common clinical intervention to relieve the symptoms of bladder dysfunction when all other methods have failed or are unsuitable. In England, Wales and Northern Ireland indwelling Foley catheters are used by 3% of people living in the community and 13% of care home residents (Royal College of Physicians, 2005). A recent study involving 253 NHS trusts found that 12.9% of patients were catheterised with the highest numbers in hospital settings and in particular critical care (Shackley et al, 2017). Box 1 lists reasons for indwelling catheter insertion.

Indwelling catheters are associated with numerous complications including catheter-associated urinary tract infection (CAUTI) (Newman, 2007), encrustation, pain, trauma, bypassing and blockage (Yarde, 2015; Loveday et al, 2014). Complications are common in community and primary care settings, and the risk of complications increases the longer the catheter remains in place.

This article reviews the current evidence and, where evidence is unavailable, expert opinion on the management of blocked catheters.

Causes of blockage

Catheter blockages fall into two groups:

- Blockages due to a mechanical dysfunction – there is a problem with the drainage system but the lumen remains clear;
- Luminal blockages – the catheter drainage lumen is occluded, usually by encrustation.

There are numerous causes of mechanical dysfunction. These are listed in Table 1, which also summarises the appropriate actions to take.

Luminal blockages mainly occur with long-term catheterisation (a catheter being in situ for more than 30 days) (Feneley et al, 2015), which is associated with CAUTIs. Normally, the body has a range of defences preventing micro-organisms from entering the urinary tract, such as:

- Tightly closed folds in the urethra;
- The flushing action of normal voiding;
- A protective surface layer of mucus.

Indwelling catheters disrupt the normal cycle of micturition and lower these natural defences. If bacteria are allowed to enter, they may travel along the inside and/or outside of the catheter tube (intra-

Box 1. Reasons for indwelling catheter insertion

Indwelling catheters may be inserted to:

- Address acute or chronic urinary retention
- Empty the bladder – for example, before pelvic surgery
- Irrigate the bladder – for example, after prostate surgery
- Accurately measure urinary output in patients who are acutely ill
- Carry out bladder function tests
- Bypass an obstruction caused, for example, by an enlarged prostate or a urethral stricture
- Administer drugs directly into the bladder
- Improve comfort for patients receiving end-of-life care
- Relieve incontinence and maintain skin integrity – this will be as a last resort after all other conservative continence management strategies have been tried

Sources: Yates (2017); Dougherty and Lister (2015); Royal College of Nursing (2012)

Table 1. Causes of mechanical dysfunction of indwelling urinary catheters

Cause	Action
Constipation and/or straining at defecation	● Assess patient for constipation and/or faecal impaction ● Advise on diet and fluid intake, review medication and consider use of laxatives
Drainage tubing occluded by kink, catheter strapping and/or tight clothing	● Ensure tubing is correct length and straight ● Advise patient (especially if wheelchair bound) to avoid sitting on drainage lumen and/or bag ● Check clothing is not too tight
Drainage bag located above the bladder	● Ensure drainage bag is located below the bladder (Loveday et al, 2014)
Drainage bag too full	● Ensure drainage bag is emptied when three-quarters full (Loveday et al, 2014)
Drainage bag and/or catheter not well supported or secured	● Ensure catheter and drainage bag are well supported and secured, and that 2L drainage bags are placed on a stand and do not touch the floor (Yates, 2016)
Unstable bladder, bladder overactivity and/or bladder spasm	● Use smallest appropriate size of catheter ● Check balloon is inflated in accordance with the manufacturer's guidance ● Advise patient on fluid intake and caffeine reduction ● Consider use of anticholinergic medication, bearing in mind anticholinergic burden in patients aged over 65 (Bishara et al, 2017)
Drainage bag too low and producing negative pressure, mucosa being sucked into catheter eyelets	● Raise bag above level of bladder for a few seconds as this will counter negative pressure and encourage return to normal flow (Feneley et al, 2015; Geng et al, 2012; Lowthian, 1998)

luminally or extra-luminally) and colonise the interior and/or exterior lumen. They may then form biofilms (Fig 1), which can become crystalline and cause encrustation (Fig 2), eventually blocking the catheter.

Nearly 50% of patients with indwelling catheters will experience blockages due to encrustation (Getliffe, 1992). Encrustation, mainly composed of struvite (magnesium ammonium phosphate) and calcium phosphate, results from normally sterile acidic urine turning alkaline due to the presence of micro-organisms (Fig 3). The most common micro-organisms causing encrustation naturally occur in the bowel and include *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *E. coli* and *Proteus mirabilis* (Stickler, 2008). *P. mirabilis* and *E. coli* are particularly likely to produce biofilm, which will break down urea into urease.

Encrustation may build up on the catheter lumen, around the catheter eyes and on the balloon. It can cause blockage leading to pain and/or trauma on removal, urine retention and bypassing. Fragments of encrustation that fall into the bladder can be precursors of bladder stones (Stickler et al, 2003).

Catheter materials and types

There are many types of catheter, and the choice depends on the outcomes of patient assessment, which should include allergies or sensitivities – especially to latex (Elvy and Colville, 2009) – reason for catheterisation and planned length of time in situ.

Manufacturers are working to develop catheter materials that can prevent the formation of biofilms, but these do not yet exist. Expert opinion suggests hydrogel and silicone catheters are the least susceptible to encrustation due to a wider drainage channel, while plain latex and Teflon coated versions are the most susceptible.

However, according to the *Cochrane Database for Systematic Reviews*, no particular type of catheter can be recommended for long-term (Jahn et al, 2012) or short-term (Lam et al, 2014) use, due to weak evidence and poorly conducted studies; good-quality trials are therefore needed in this area. The best recommendation that can be made is to remove the catheter as soon as possible if its use is no longer indicated.

Vaidyanathan et al (2009) reported extremely positive results with the use of an open-ended catheter in a case of severe encrustation. A catheter of this sort for severe encrustation is now manufactured by LINC Medical Systems and is available on prescription (Yates, 2012).

Catheter patency solutions

Three types of solution are available to help with blocked catheters (Box 2). These solutions are often called 'catheter maintenance solutions' or 'catheter washouts', but the correct term is 'catheter patency solutions'. Chlorhexidine 0.02%, an antiseptic solution aimed at preventing bacterial growth, was commonly used in the past but is no longer recommended as it may contribute to the development of resistant strains of bacteria (Yates, 2012).

In a recent Cochrane review, Shepherd et al (2017) identified that studies on catheter patency solutions were limited, of poor-quality and poorly reported. The authors concluded that there was insufficient evidence to determine whether the use of such solutions was beneficial or harmful to patients, and that further trials were needed.

Fig 1. **Biofilm formation**

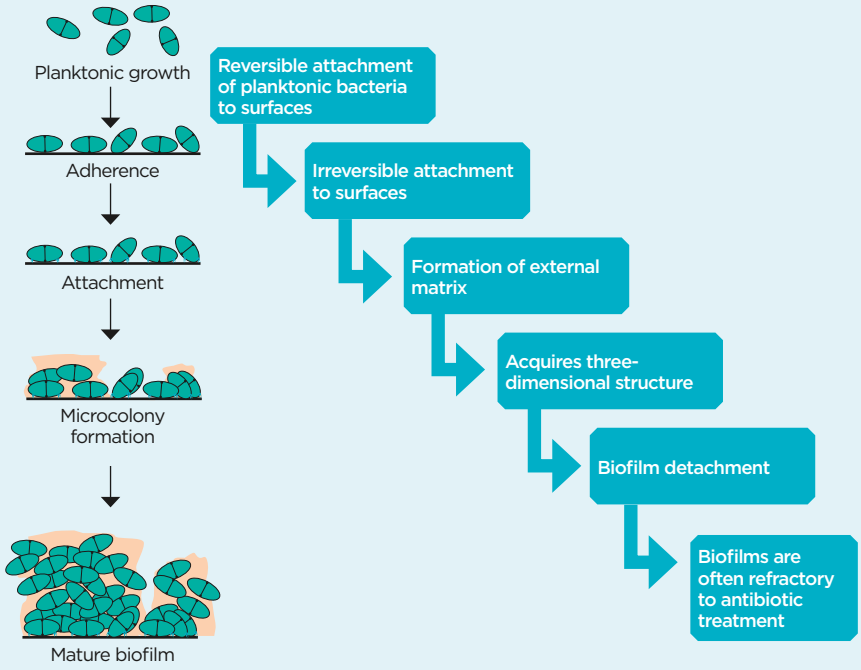
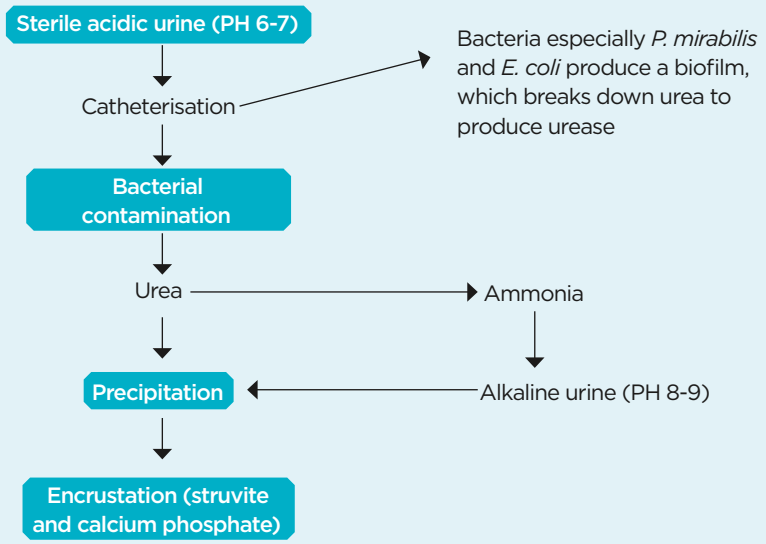


Fig 2. **Catheter encrustation**

Fig 2a. Encrustation can form on the outside of the catheter

Fig 2b. Encrustation can form on the inside wall of the catheter

Fig 3. **Encrustation development**



Indications for use

The use of catheter patency solutions should be based on need after an assessment that involves:

- Removing the catheter suspected of being blocked;
- Examining it;
- Cutting it lengthwise to check its contents;
- Determining the extent of, and reason for, the blockage.

Catheter blockages should be recorded to establish patterns of blockage causes as well as the average catheter lifespan.

National guidance on infection prevention and control in primary and community care states that catheter patency solutions should only be used to extend the lifespan of the catheter when the frequency of catheter changes due to blockage from encrustation is unacceptable; in such cases a prescribed regimen of an acidic catheter maintenance solution may be justified (National Institute for Health and Care Excellence, 2012). For example, if a patient's catheter has been found to block every four weeks, it could be changed every three weeks or the life of the catheter could be extended using a patency solution.

Catheter patency solutions should not be used prophylactically to prevent CAUTIs, nor should they be used routinely to attempt to unblock a blocked catheter. They should only be used to extend the life of a catheter that may be likely to block (NICE, 2012).

If a catheter is totally blocked from luminal obstruction the ideal intervention would be to remove the catheter, examine it and replace it with a new one. Shepherd et al's (2017) review identified that studies of solutions were limited, of poor-quality methodology and poorly reported; it did not state whether solutions are beneficial or not but calls for more research to be undertaken.

Principles of use

Catheter patency solutions are designed to mechanically rinse out the catheter rather than be instilled into the bladder. They must be prescribed according to local policy and administered following manufacturer guidelines. Solutions should be at room temperature before use as instilling hot or cold fluids can cause bladder spasms or even a degree of shock.

The procedure requires an aseptic technique, so a sterile pack must be used and local polices for use of catheter patency solutions should be followed.

It is important to record the procedure in the patients notes and evaluate its effectiveness.

There is currently no evidence or consensus on how much solution is required to be effective in unblocking a catheter, but there is some evidence that two sequential 50ml rinses are more effective than either one 50ml or one 100ml rinse (Yates, 2012).

The frequency of use should be guided by clinical judgement and the patient's history of catheter blockages. Every time a catheter patency solution is used, the catheter is no longer a closed system; it is therefore open to invasion by micro-organisms, so use should be kept to a minimum.

Using catheter patency solutions requires good monitoring and record keeping, as well as adherence to manufacturers' instructions on how to administer their solutions.

A new product

Polihexanide is a broad-spectrum antimicrobial that has been successfully used in bacterial decolonisation and prevention of biofilm formation in wound care (Bradbury and Fletcher, 2011). The manufacturer of a new catheter patency solution, Uro-Tainer Polihexanide claims it prevents bacteria adhering to the catheter, consequent biofilm formation and catheter encrustation. It is available as 100ml 0.02% sterile solution. Nurses should be aware of cautions and contraindications, which include hypersensitivity to polihexanide or chlorhexidine, presence of cystitis or haematuria, and use after surgery of the bladder or urinary tract (Bit.ly/BBraunUroTainer-Polihexanide).

Implications for practice

Urinary catheter blockage is a frequent problem occurring mainly with long-term catheter use. Community and primary care professionals are generally responsible for managing blockages, but there is little evidence to support them. It is crucial that they understand:

- The different types and causes of catheter blockage;
- How biofilm develops;
- When to use catheter patency solutions, ruling out any possible mechanical cause of blockage and ascertaining the presence of luminal blockage before taking steps to resolve it.

Good catheter blockage management also involves recording patients' catheter history, pre-empting catheter changes if possible, and assessing blocked catheters adequately. Finally, professionals need to keep a lookout for innovations in catheter materials and patency solutions. **NT**

Box 2. Commonly used catheter patency solutions

- Normal saline (0.9% solution, pH = 7) – has a neutral pH and is used to maintain catheters blocked with pus, blood clots or debris; it will not dissolve encrustation so should not be used for blockage resulting from encrustation
- Solution G (3.23% citric acid, pH = 3-4) – an acidic solution that will dissolve encrustation; it contains magnesium oxide to help prevent bladder irritation
- Solution R (6% citric acid, pH = 2) – also contains magnesium oxide but is stronger than solution G and will dissolve severe encrustation; can be used for patients who have tried solution G without success or who experience discomfort on catheter withdrawal due to encrustation around the tip of the device

Source: Yates (2012)

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