Peer reviewed article

Long-term urinary catheter-associated urinary tract infection (UTI)

Abstract

This paper reviews the literature on the current management of symptomatic urinary tract infections (UTIs) in those with long-term urinary catheters. Long-term is defined as being in situ for more than 1 month. The discussion refers to published guidelines and relevant clinical trials.

As bacteriuria is universal in people with long-term urinary catheters, diagnosis of symptomatic UTIs is made chiefly by the presence of clinical symptoms, which usually include fever. Urine culture is then performed in order to direct an appropriate antibiotic choice. Urinary catheter change at the time of initiating treatment is likely to lead to earlier clinical improvement, and a more accurate assessment of infecting organisms when a culture is taken via the new catheter. Antibiotic treatment should be for as short a time as possible, 5-7 days, to reduce the selection of resistant microorganisms. Regular catheter change and newer catheter materials have not been proven to reduce the incidence of symptomatic UTIs in those with a long-term urinary catheter in situ.

Key words: urinary tract infection, urinary catheter, antibiotics, urinalysis.

Introduction

Urinary tract infections (UTIs) were studied extensively in the 1980s; this led to the development of evidence-based guidelines for treatment in those with normal urinary tracts. Since that time, further areas have been elucidated by excellent trials, such as the treatment of UTIs in pregnancy and in those in long-term care facilities, and also whether treatment of asymptomatic bacteriuria is appropriate.

Studies on the prevention of UTIs in patients with a urinary catheter have mainly addressed those with short-term urinary catheterisation (usually less than 14 days) in recent years. In respect to long-term urinary catheterisation, various clinical issues have been investigated – such as presentation, diagnosis and treatment of symptomatic UTIs – focusing on particular groups, including the institutionalised elderly and those with spinal cord lesions. This has resulted in a number of recommendations regarding long-term urinary catheter-related UTIs, but many areas remain to be clarified by further studies.

The purpose of this article is to present what is a current evidence-based management strategy for those with long-term catheter-associated UTIs.

Literature review methodology

Material for this article was identified by searches of Medline, Cochrane Reviews and references from relevant original articles published in English between 1994 and 2004. Search terms included catheter, urinary catheter, urinary tract infection, and were combined with the terms review and guidelines.

Bacterial urinary tract colonisation and persistence

Following insertion of a urinary catheter, bacteria spread to the bladder and establish persistence there, with subsequent intermittent invasion leading to symptomatic UTIs. A long-term urinary catheter is defined as: one that is required for more than a month; is most commonly used either to manage incontinence, particularly in women; or as an intervention for bladder outlet obstruction with retention, more commonly in men.

A normal bladder has very effective defences against transient bacteriuria, with most organisms being removed by the next urination. Unfortunately, inserting an indwelling urinary catheter bypasses many of these host defences, allowing access of organisms to the bladder. Initially, the urethra will become colonised, then organisms ascend to cause bladder colonisation. These colonising perineal organisms usually consist of normal bowel flora such as Enterococcus, Escherichia coli and other Gram-negative bacilli, skin flora such as coagulase-negative
Staphylococci and Candida. In women, colonising organisms can include normal vaginal flora such as Group B Streptococcus. Colonising organisms may also include hospital-associated organisms with which the person has come in contact such as methicillin resistant Staphylococcus aureus (MRSA).

Closed urinary catheter drainage systems have been successful in greatly reducing access of organisms to the bladder via the lumen of the catheter, with the result that most ascending colonisation now occurs via the external surface of the catheter. However, with closed drainage systems, detaching the collection tube from the catheter can allow organisms entry into the system, as can contamination of the emptying tube of the bag with a dirty container.

In all urinary catheterisation, the catheter balloon prevents complete emptying of the bladder, causing a small volume of residual urine to accumulate, thus providing a suitable medium for persistence and multiplication of organisms once they have entered the urinary bladder. The development of persistent bacteriuria occurs at a rate of 3-10% per day following urinary catheterisation, with all urinary catheters becoming colonised after 1 month in situ. This persistence of bacteria in the urine of catheterised patients is termed ‘asymptomatic bacteriuria’ or more correctly ‘asymptomatic UTIs’, as there is evidence of a host response involved implying a degree of tissue invasion rather than mere surface colonisation.

Organism factors also facilitate bacterial persistence in the bladder, most notably those properties that promote their adherence to the bladder uroepithelial lining and catheter surface. A biofilm forms on the surface of the catheter, consisting of glycocalyx slime and minerals. This biofilm facilitates bacterial attachment and provides protection from normal host defences. In particular, there is a blunting of the host antibody and neutrophil response which might normally eradicate bacteria. Bacterial persistence occurs initially in the bladder but may extend to the kidneys, with biofilm being formed in the renal pelvis or tubules. Chronic renal inflammation has commonly been found at autopsy of those with long-term urinary catheters, but actual chronic pyelonephritis with scarring is much less frequent, occurring mainly in people with renal stones.

Long-term catheters are usually colonised by two to five different organisms. These organisms are replaced by other organisms regularly, and can change as frequently as every 2 weeks. Some organisms are more persistent as they adhere better to the uroepithelium, particularly E. coli and Providencia stuartii. Over time, more antibiotic-resistant organisms may be selected, particularly by the use of multiple antibiotic treatment courses.

**Prevention of symptomatic UTIs in catheterised persons**

Various measures have been suggested to prevent the development of urinary catheter-associated bacteriuria but, apart from the closed drainage system, to date, none have been proven to be effective. Periurethral topical antibiotics have not been shown to prevent the development of urinary catheter bacteriuria. Prophylactic antibiotics have been found to delay the development of bacteriuria in short-term catheterised patients, but eventually resistant organisms colonise the urinary catheter. In the long-term catheterised patient, urine sterility cannot be maintained with antibiotics. Routine urinary catheter change has not yet been proven, in any study, to reduce the incidence of UTIs in people with long-term urinary catheters.

While published recommendations for the timing of urinary catheter change are few, it is reasonable that catheters not associated with complications be left in place for 12 weeks. Antibiotic prophylaxis at the time of urinary catheter change is not recommended as, despite a 4-10% incidence of transient bacteraemia associated with the procedure, symptomatic infection is uncommon. Routine catheter irrigation with antimicrobial agents has been shown to be ineffective in preventing UTIs. Suprapubic catheterisation, compared to urethral catheterisation, has been suggested as an alternative, as the abdominal skin carries less of a bacterial load than the periurethral area. However, this option has not been well studied in terms of UTI incidence in a long-term catheterised group and no conclusions can be drawn.

In an attempt to reduce bacterial adhesion, materials such as Teflon and silicon have been used in catheter construction, but no reduction in UTI incidence has been shown. In individual patients, however, more frequent routine catheter change and a silicon catheter may reduce urinary catheter blockage if this is the cause of their recurrent UTIs.

Antimicrobial impregnated or silver-coated urinary catheters have had variable success in preventing UTIs in those catheterised for less than 14 days, with silver alloy coated catheters particularly showing some promise. There is insufficient evidence to comment on the use of these urinary catheters in long-term catheterised patients, but there is some concern regarding silver toxicity from prolonged use.

Future options for reducing symptomatic UTIs lie particularly in the development of alternatives to permanent indwelling catheters, such as urethral stents and condom drainage for males. Intermittent catheterisation is thought to be associated with a lower rate of symptomatic UTIs, although no definitive study has been performed. Vaccines against the common UTI...
pathogens such as *E. coli* are being developed but, while these are very promising in people with normal urinary tracts, it remains to be seen whether they will be effective when there is a urinary catheter *in situ*.

**Symptomatic UTIs in the long-term catheterised**

Progression from an asymptomatic infection to symptomatic UTIs can be related to a number of factors. Catheter obstruction is the most common cause of symptomatic UTIs, with fever eight times more common in those with obstruction than with a patent urinary catheter. Obstruction leads to increased residual urine in the bladder in which colonising organisms multiply. Obstruction is often caused by a combination of precipitated crystals, biofilm, Tamm-Horsfall protein (antibacterial mucus normally made in the kidneys) and bacteria.

Of particular note, urinary colonisation with Proteus species may lead to obstructive problems as the organism produces the enzyme urease. This catalysis of the breakdown of urea into ammonia and the subsequent alkaline urine allows the development of a precipitate of struvite and apatite crystals. A similar process may cause kidney and bladder stones. Obstruction does not necessarily lead to UTIs if the catheter is changed as soon as obstruction occurs.

Catheter trauma also contributes to the development of symptomatic UTIs by causing mechanical uro-epithelial damage, facilitating invasion of organisms into deeper tissue.

**Clinical presentation**

Symptomatic UTIs in catheterised patients may be over-diagnosed, with non-specific signs such as delirium in an elderly mistakenly attributed to infection from a urinary source.** Purely lower UTI symptoms such as dysuria are uncommon and perirethral infection as a cause of these symptoms, particularly in men, should be excluded by examining the urethral meatus for discharge and checking for epididymitis or prostatitis. Bladder spasms may cause symptoms if the catheter is blocked but this cause should be obvious on examination.

Symptoms of UTIs such as gross haematuria or loin pain consistent with pyelonephritis, or persistent fever with no other obvious source, correlate with acute symptomatic urinary infection. In patients with a long-term urinary catheter, fever occurs at a rate of 0.7-1.2 fevers per 100 days of catheterisation. However, the majority of these fevers only last 1 day and settle without treatment, leaving approximately 30% of fevers with no obvious source that are actually due to symptomatic UTIs. Elevated peripheral blood white cell count and, in some patients, positive blood cultures, also support the diagnosis of symptomatic UTIs compared to asymptomatic bacteriuria. Of note, the risk of death is 60 times higher in febrile catheterised patients with UTIs than in those who are afebrile.

**Laboratory findings**

When a clinical diagnosis of symptomatic UTIs has been made, urine microscopy and culture provides useful information to direct appropriate antibiotic therapy. Examination of urine in patients with a urinary catheter frequently shows pyuria due to mechanical irritation so the presence of white cells is unhelpful in diagnosing symptomatic UTIs. However, conversely the absence of white cells on urinalysis or microscopy has excellent negative predictive value and is useful as evidence against UTIs, suggesting than an alternative source of the patient’s current symptoms should be sought.

Diagnosis of UTIs cannot be based purely upon culture as almost all catheter urine specimens will grow organisms. When obtaining a specimen of urine for diagnostic purposes, it is important to realise that a urine sample taken from a urinary catheter reflects organisms present in the biofilm on the catheter, and not solely the organisms that are actually present in the bladder. A greater variety of organisms plus higher numbers of these organisms will be isolated from the colonised catheter compared to a sample taken from the bladder when a new catheter is inserted. Thus catheter culture samples are not necessarily representative of the actual organism causing an episode of symptomatic UTIs. Preferably a urine sample should be taken from a newly inserted urinary catheter at the time of symptomatic UTI diagnosis to determine what organisms are present in the bladder.

**Treatment**

Ideally the urinary catheter should be changed every time a symptomatic UTI is diagnosed and treated. The disadvantages of changing the urinary catheter are a 4-10% rate of transient, usually asymptomatic bacteraemia associated with the procedure, plus potential mechanical trauma involved and financial costs.

A study of aged nursing home patients looking at catheter replacement prior to starting treatment of symptomatic UTIs found that inserting a new urinary catheter in addition to treating with antibiotics led to clinical improvement after 3 days in 93% versus 41% of patients without catheter change, although all had a similar clinical outcome eventually. There was also a lower rate of symptomatic relapse 4 weeks after treatment cessation in those who had urinary catheter replacement. This has led to a recommendation for replacement when the catheter has been *in situ* for more than 7 days. If the catheter is not being replaced, a sample of urine should be aspirated from the catheter port.
Antibiotic treatment of UTIs in people who have a urinary catheter in situ in the long-term is aimed at symptom relief rather than eradication of bacteriuria and thus should be for as short a time as possible, usually 5-7 days. This is because a longer antibiotic course will still not sterilise the urine for any prolonged time and may lead to bacteriuria with more resistant microorganisms.

In mildly symptomatic patients with only a low-grade fever, it is appropriate to wait for urine culture results to enable an appropriate antibiotic to be chosen. Once susceptibilities are available, a suitable oral antibiotic can be prescribed from trimethoprim 300mg daily, cephalexin 500mg twice daily, amoxicillin plus clavulanate 500/125mg twice daily or nitrofurantoin 50mg four times a day. Empiric antibiotics should be started immediately in those with severe symptoms such as rigors or hypotension; for these people, a broad-spectrum antibiotic should be chosen to cover a wide range of potential infecting organisms such as ciprofloxacin (not recommended for children) or intravenous gentamicin 5mg/kg/day as a single daily dose plus ampicillin 1g 6-hourly.

For severely unwell patients in whom gentamicin is contraindicated, ceftriaxone 1g daily intravenously or intramuscularly may be used, but this has no activity against Pseudomonas. On occasion when the patient is known from past urine cultures to be persistently colonised with a microorganism that is resistant to the latter antibiotics, the empiric initial antibiotic used should be one that the organism is known to be susceptible to.

There is no evidence that increased hydration improves further on the clinical response to antibiotic treatment for uncomplicated UTIs and it is not recommended. Forcing fluids has the theoretical disadvantage of causing increased vesico-ureteric reflux, and dilution of antibiotic and natural antibacterial substances in the urinary tract. It also leads to decreased acidification of the urine, which lessens the activity of some antibiotics. Urinary acidification with oral agents is rarely necessary in the treatment of UTI and is difficult to achieve as it requires dietary modification as well as the administration of agents such as ascorbic acid or methionine. These compounds may precipitate in the urine and cause urate or oxalate stones to form, or cause acidosis in patients with renal impairment.

Urine pH alters the activity of some antibiotics, with nitrofurantoin more active in acid urine and aminoglycosides more active in alkaline urine; the effectiveness of these agents is adequate with normal urine pH. If infection symptoms fail to settle and the urinary catheter is not blocked, then investigation for stones in the kidneys or bladder should be performed. For men with relapsing infection with the same organism, a 4 week antibiotic course of treatment should be considered for possible occult prostatitis. Options include ciprofloxacin and trimethoprim as few antibiotics penetrate the prostate well.

Urine culture following resolution of UTI symptoms and cessation of antibiotic is not recommended in patients with a long-term urinary catheter as it is likely to still show bacteriuria and does not influence further management.

Conclusion

UTIs are a common cause of morbidity in people with a long-term urinary catheter in situ. No measures, apart from the closed drainage system, have yet been proven to be effective in preventing UTIs in this group of patients. Diagnosis of UTIs should be based on symptoms, particularly fever.

Urinary catheter change is recommended prior to starting treatment of symptomatic UTIs as symptoms resolve more rapidly and there is a lower rate of symptom recurrence in the following 4 weeks. A urine sample should be taken from the new catheter for culture and subsequent antibiotic treatment directed by the result. Antibiotic treatment should be given for 5-7 days to reduce the risk of acquisition of resistant microorganisms colonising the urinary tract. Further clinical trials of preventive measures regarding UTI in long-term catheterised persons are required to assist in formulating management strategies.

References

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