

Guidelines: short-term indwelling urethral catheters

Harper PJ, Pratt RJ, Pellowe CM, Wilson JA, Loveday HP, Jones SRLJ, McDougall C, Wilcox MH.

Published: 18 July 2007 12:50

Last Updated: 18 July 2007 12:50

These guidelines advise health professionals and providers on preventing infections associated with the use of short-term indwelling urethral catheters. They are based on the best critically appraised evidence currently available. The type and class of supporting evidence explicitly linked to each recommendation is described. All recommendations are endorsed equally and none is regarded as optional. These recommendations are not detailed procedural protocols and need to be incorporated into local guidelines (Pratt et al, 2007).

These guidelines advise health professionals and providers on preventing infections associated with the use of short-term indwelling urethral catheters. They are based on the best critically appraised evidence currently available. The type and class of supporting evidence explicitly linked to each recommendation is described. All recommendations are endorsed equally and none is regarded as optional. These recommendations are not detailed procedural protocols and need to be incorporated into local guidelines (Pratt et al, 2007).

The guidance applies to adults and children aged one year and older and should be read in conjunction with the guidance on Standard Principles (articles 1 and 2 in this series). The recommendations are divided into five distinct interventions:

- Assessing the need for catheterisation;
- Selection of catheter type and system;
- Catheter insertion;
- Catheter maintenance; and
- Education of patients, relatives and healthcare workers.

Background and context

Catheter associated urinary tract infection (CAUTI) is the most common nosocomial infection. Most bacteria causing these infections gain access to the urinary tract either extraluminally or intraluminally. Extraluminal contamination may occur as the catheter is inserted, from the healthcare worker's hands or the patient's own colonic or perineal flora. It is also thought to occur by microorganisms ascending from the perineum. Intraluminal contamination occurs by reflux of bacteria from a contaminated urine drainage bag.

Bacteria quickly develop into colonies known as biofilms, which adhere to the catheter surface and drainage bag and encase themselves in an exopolymeric material. Such bacteria are morphologically and physiologically different from free-living planktonic bacteria. Bacteria in biofilms have considerable survival advantages over free-floating organisms, being extremely resistant to antibiotic therapy. These biofilms cause further problems if the bacteria produce the enzyme urase, such as *Proteus mirabilis*. The urine then becomes alkaline, causing the crystallisation of calcium and magnesium phosphate within it. This is incorporated into the biofilm, resulting in encrustation of the catheter. Encrustation is generally associated with long-term catheterisation, as it has a direct relationship with the length of catheterisation.

Assessing the need for catheterisation

There is consistent evidence that a significant number of healthcare-associated infections in hospital are related to urinary catheterisation (Ward et al, 1997; Wong and Hooton, 1983; Dieckhaus and Garibaldi, 1998; Kunin, 1997).

The risk of infection is associated with the method and duration of catheterisation, the quality of catheter care and host susceptibility. Urinary catheterisation is a frequent intervention during clinical care in hospital, affecting a significant number of patients, and the highest incidence of infection is associated with indwelling urethral catheterisation (Stamm, 1998). Many of these infections are serious and lead to significant morbidity - 20-30% of catheterised patients develop bacteriuria, of whom 2-6% develop symptoms of CAUTI (Stamm, 1998).

The risk of acquiring bacteriuria is approximately 5% for each day of catheterisation (Garibaldi et al, 1982; 1980). Of patients with a CAUTI, 1-4% develops bacteraemia and 13-30% of these die (Ward, 1997; Wong and Hooton, 1983). Duration of catheterisation is strongly associated with risk of infection, i.e., the longer the catheter is in place, the higher the incidence of urinary tract infection Stamm, 1998; Garibaldi et al 1982; 1980; Saint and Lipsky, 1999).

Advice from best practice emphasises the importance of documenting all procedures involving the catheter or drainage system in patients' records (Ward et al, 1997) and providing patients with adequate information in relation to the need for catheterisation and details of the insertion, maintenance and removal of their catheter (Ward et al, 1997; Mallett and Bailey, 1996). There is some evidence to suggest that computer management systems improve documentation and in so doing reduce the length of time catheters are in situ (Cornia et al, 2003).

UC1	Only use indwelling urethral catheters after considering alternative methods of management.	Class D/GPP
UC2	Document the need for catheterisation, catheter insertion and care.	Class D/GPP
UC3	Review regularly the patient's clinical need for continuing urinary catheterisation and remove the catheter as soon as possible.	Class D/GPP

Selection of catheter type

Current evidence-based guidelines (Pratt et al, 2001) identified three experimental studies that compared the use of latex with silicone catheters (Lopez-Lopez et al, 1991; Nickel et al, 1989; Talja et al, 1990); no significant difference in the incidence of bacteriuria was found. Four studies compared the use of silver-coated (silver alloy or silver oxide) catheters with silicone, hydrogel or Teflon latex (Riley et al, 1995; Jpohnson et al, 1990; Liedberg et al, 1990; Liedberg and Lundeborg, 1990). A systematic review and meta-analysis of these and other studies found that silver alloy (but not silver oxide) catheters were associated with a lower incidence of bacteriuria (Saint and Lipsky, 1999; Saint et al, 1998).

New evidence related to the efficacy of using urinary catheters coated or impregnated with antiseptic or antimicrobial agents has emerged since our original review in 2000. Two subsequent reviews (Pellowe et al, 2004; 2003), together with the current update review, identified four systematic reviews and one meta-analysis that examined this issue (Brosnahan et al, 2004; Johnson et al, 2006; Saint et al, 1998; Dunn et al, 2000; Niel-Weise et al, 2002).

In general, all five studies suggested antiseptic-impregnated or antimicrobial-coated urinary catheters can significantly prevent or delay the onset of CAUTI compared with standard untreated catheters. However, the consensus was that the individual studies reviewed were generally of poor quality; for instance in one case (Saint et al, 1998) only eight studies out of 117 met the inclusion criteria and in another (Niel-Weise et al 2002), of six reports describing seven trials only one scored 5 in the quality assessment, while the others scored only 1.

Studies investigating a wide range of coated or impregnated catheters are explored in the new evidence including: catheters coated or impregnated with: silver alloy (Brosnahan et al, 2004; Saint et al, 1998; Niel-Weise et al, 2002; Verleyen et al, 1998; Karcmer et al, 2000; Saint et al, 2000; Newton et al; 2002; Gentry and Cope, 2005; Madeo et al, 2004; Rupp et al, 2004); silver oxide (Saint et al, 1998); gentine (Cahiban et al, 2000); gentamicin (Cho et al, 2003) and silver-hydroge (Thobon et al, 2000; Lai, 2002; Gaonkar et al, 2003); minocycline (Darouche et al, 2003); rifampicin (Darouche et al, 2003); chlorhexidine-silver sulfadiazine (Gaonkar et al, 2003); chlorhexideine-sulfadiazine-triclosan (Gaonkar et al, 2003); nitrofurazone (Gaonkar et al, 2003); and nitrofuraxone (Al-Habdan et al, 2003).

New evidence suggests that catheters coated with silver alloy are clinically effective in reducing the incidence of CAUTI, but many studies are of poor methodological quality. Consequently there remains inconclusive evidence to recommend their use in preference to other types of catheter at this time. Despite their unit cost, there is a suggestion that these devices might be a cost-effective option if overall numbers of infections are significantly reduced through their use. However, the few studies that have explored the cost benefit/effectiveness of using these devices have also been inconclusive (Saint et al, 2000; Gentry and Cope, 2005; Rupp et al, 2004; Lai, 2002).

Evidence from best practice indicates that the incidence of CAUTI in patients catheterised for a short time (up to one week) is not influenced by any particular type of catheter material (Pomfret, 1996; Kunin, 1997). However, many practitioners have strong preferences for one type of catheter over another. This preference is often based on clinical experience, patient assessment, and which materials induce the least allergic response. Smaller gauge catheters with a 10 ml balloon minimise urethral trauma, mucosal irritation and residual urine in the bladder, all factors that predispose to CAUTI (Dieckhaus and Garibaldi, 1998; Roe and Brocklehurst 1987). However, in adults that have recently undergone urological surgery larger gauge catheters may be indicated to allow for the passage of blood clots.

- | | | |
|-----|---|----------------|
| UC4 | Choice of catheter material will depend on clinical experience, patient assessment and anticipated duration of catheterisation. | <i>Class D</i> |
| UC5 | Select the smallest gauge catheter that will allow free urinary outflow. A catheter with a 10 ml balloon should be used in adults. Urological patients may require larger gauge sizes and balloons. | <i>Class D</i> |

Catheter insertion

Catheterisation is a skilled aseptic procedure. Despite evidence from one systematic review (Dunn et al, 2000) suggesting that the use of aseptic technique has not demonstrated a reduction in the rate of CAUTI, principles of good practice, clinical guidance (Ward et al, 1997; Wong and Hooton, 1983) and expert opinion (Dieckhaus and Garibaldi, 1998; Stamm, 1998; Kass and Schneiderman, 1957; Desautels et al, 1962; Kunin and McCormack, 1966; Kunin, 1997; Garibaldi et al, 1974), together with findings from another systematic review (Saint and Lipsky, 1999) agree that urinary catheters must be inserted using sterile equipment and an aseptic technique.

Expert opinion indicates that there is no advantage in using antiseptic preparations for cleansing the urethral meatus prior to catheter insertion (Dunn et al, 2000; Kunin and McCormack, 1997). Urethral trauma and discomfort will be minimised by using an appropriate sterile, single-use lubricant or anaesthetic gel. Ensuring healthcare practitioners are trained and competent in the insertion of urinary catheters will minimise trauma, discomfort and the potential for CAUTI (Ward et al, 1997; Dieckhaus and Garibaldi, 1998; Kunin and McCormack, 1997; Garibaldi et al, 1974).

- | | | |
|-----|---|----------------|
| UC6 | Catheterisation is an aseptic procedure. Ensure that health care workers are trained and competent to carry out urethral catheterisation. | <i>Class D</i> |
| UC7 | Clean the urethral meatus with sterile normal saline prior to the insertion of the catheter. | <i>Class D</i> |
| UC8 | Use an appropriate lubricant from a sterile single use container to minimise urethral trauma and infection. | <i>Class D</i> |

Catheter maintenance

Maintaining a sterile, continuously closed urinary drainage system is central to the prevention of CAUTI (Thornton and Andriole, 1970; Kunin and McCormack, 1966; Gillespie et al, 1983; Ward et al, 1997; Dieckhaus and Garibaldi, 1998; Wong and Hooton, 1983). The risk of infection reduces from 97% with an open system to 8-15% with a sterile closed system (Gillespie et al, 1964; Garibaldi et al, 1974; Kunin, 1997).

Breaches in the closed system such as unnecessary emptying of the urinary drainage bag or taking a urine sample, will increase the risk of CAUTI and should be avoided (Ward et al, 1997; Kunin, 1997; Platt et al, 1983). Hands must be decontaminated and clean, non-sterile gloves worn before manipulation. A systematic review (Dunn et al, 2000) suggested that sealed (for example taped, pre-sealed) drainage systems contribute to preventing bacteriuria.

There is limited evidence as to how often catheter bags should be changed. One study showed higher rates of symptomatic and asymptomatic CAUTI where associated with a three-day urinary drainage bag change regimen when compared to no routine change regimen (Keerasuntonpong, et al, 2003). Best practice suggests changing only when necessary, that is according to either manufacturers' recommendations or the patient's clinical need (Ward et al, 1997; Wong and Hooton, 1983). Reflux of urine is associated with infection and consequently, drainage bags should be positioned in a way that prevents back-flow of urine (Ward et al, 1997; Dieckhaus and Garibaldi, 1998). It is also recommended

that urinary drainage bags should be hung on an appropriate stand that prevents contact with the floor (Kunin, 1997).

A number of studies have investigated the addition of disinfectants and antimicrobials to drainage bags as a way of preventing CAUTI (Saint and Lipsky, 1999). Three acceptable studies (Sweet et al, 1985; Maizels and Shaeffer, 1980; Thompson et al, 1984) from our original systematic review (Pratt et al, 2001) demonstrated no reduction in the incidence of bacteriuria following the addition of hydrogen peroxide or chlorhexidine to urinary drainage bags. A systematic review supports these findings in that it suggests that adding bacterial solutions to drainage bags has no effect on catheter associated infection (Dunn et al, 2000).

UC9	Connect indwelling urethral catheters to a sterile closed urinary drainage system.	Class A
UC10	Ensure that the connection between the catheter and the urinary drainage system is not broken except for good clinical reasons, e.g., changing the bag in line with manufacturer's recommendation.	Class A
UC11	Decontaminate hands and wear a new pair of clean, non-sterile gloves before manipulating a patient's catheter and decontaminate hands after removing gloves.	Class D
UC12	Obtain urine samples from a sampling port using an aseptic technique.	Class D/GPP
UC13	Position urinary drainage bags below the level of the bladder on a stand that prevents contact with the floor.	Class D/GPP
UC14	Empty the urinary drainage bag frequently enough to maintain urine flow and prevent reflux. Use a separate and clean container for each patient and avoid contact between the urinary drainage tap and container.	Class D/GPP
UC15	Do not add antiseptic or antimicrobial solutions into urinary drainage bags.	Class A
UC16	Do not change catheters unnecessarily or as part of routine practice except where necessary to adhere to the manufacturer's guidance.	Class D/GPP

Appropriate maintenance minimises infections

Meatal cleansing with antiseptic solutions is unnecessary

Our original systematic review (Pratt et al, 2001) considered six acceptable studies that compared meatal cleansing with a variety of antiseptic/antimicrobial agents or soap and water. No reduction was demonstrated in bacteriuria when using any of these preparations for meatal care compared with routine bathing or showering (Cleland et al, 1971; Burke et al, 1983; 1981; Classen et al 1991a; 1991b; Huth et al, 1992). Our subsequent reviews (Pellow et al, 2004; 2003) revealed two studies (Dunn et al, 2000; Webster et al, 2001) that support these findings in that the outcomes indicate that the use of antiseptics provides no benefit in respect of meatal/peri-urethral hygiene.

Expert opinion (Dieckhaus and Garibaldi, 1998; Wong and Hooton, 1983; Kunin, 1997) and another systematic review (Saint and Lipsky, 1999) support the view that vigorous meatal cleansing is not necessary and may increase the risk of infection and that daily routine bathing or showering is all that is needed to maintain meatal hygiene.

UC17	Routine daily personal hygiene is all that is needed to maintain meatal hygiene.	Class A
------	--	---------

Irrigation, instillation and washout do not prevent infection

None of the evidence in our systematic review demonstrated any beneficial effect of bladder irrigation, instillation or washout with a variety of antiseptic or antimicrobial agents in preventing catheter-associated infection (Pratt et al, 2001; Davies et al, 1987; Ball et al, 1987; Jones and Hasan, 1988; Schneeberger et al, 1992; Warren et al, 1978; Muncie et al, 1989; Kennedy et al, 1992; Cox et al, 1966; Getliffe, 1994a; Kennedy and Brocklehurst, 1992; Saint and Lipsky, 1999). However, three studies suggest that an acid washout solution (Suby G) is effective in reducing catheter encrustation (Getliffe et al, 2000; Kennedy and Brocklehurst, 1992; Getliffe, 1994b).

Evidence from best practice supports the findings in respect of bladder irrigation, instillation and washout and indicates that the introduction of such agents may have local toxic effects and contribute to the development of resistant microorganisms. However, continuous or intermittent bladder irrigation may be indicated during urological surgery or to manage catheter obstruction (Wong and Hooton, 1983; Saint and Lipsky, 1999; Dickhaus and garibaldi, 1998; Ward et al, 1997; Kunin, 1997).

UC18	Bladder irrigation, instillation and washout should not be used to prevent catheter-associated infection.	Class A
------	---	---------

Education of patients, relatives and healthcare workers

Given the frequency of urinary catheterisation in hospital patients and the associated risk of CAUTI, it is important that patients, their relatives and healthcare workers responsible for catheter insertion and management are educated about infection prevention. All those involved must be aware of the signs and symptoms of infection and how to access expert help when difficulties arise. Healthcare professionals must be confident and proficient in associated procedures.

UC19	Healthcare workers must be trained in catheter insertion and maintenance.	Class D/GPP
UC20	Patients and relatives should be educated about their role in preventing urinary tract infection.	Class D/GPP

Areas for further research

In developing the recommendations we identified several areas that were inadequately addressed in the literature. We recommend further research in the following areas.

Intervention 1: Assessing the need for catheterisation

Epidemiological studies of the prevalence and incidence of bacteriuria/ urinary tract infection during short-term catheterisation in different populations and different care settings. These should at least encompass the predominant populations; older people and those undergoing surgery. There needs to be clear definition of the 'cases' and the populations from which they are drawn.

Intervention 2: Selection of catheter type

Randomised controlled trials of the efficacy of antiseptic/antimicrobial coated/impregnated urethral catheters for short-term use. These need to be high quality studies, using the hospital's actual catheter-associated UTI prevalence rather than national data, and appropriate follow-up.

Intervention 4: Catheter maintenance

Randomised controlled trials of strategies to establish how often catheters and catheter bags need to be changed.

Key audit criteria

Apart from providing practice advice, guidelines can also be used as audit criteria to measure adherence. Below are some examples of how these guidelines can be used.

Aim	Criteria
Identify all patients with indwelling urinary catheters, their clinical need for catheterisation, assessed and documented.	All patients should have a patient record that documents the reason for catheterisation, type of catheter, catheter insertion, changes and care. Standard 100% Data collection: review of patient notes
Ensure that all healthcare workers are trained and competent in urinary catheterisation.	Healthcare workers receive training and updates in the management of urinary catheters. Standard 100% Data collection: review of staff education records
To prevent catheter-associated urinary tract infections (CAUTI)	All healthcare workers decontaminate their hands and wear a new pair of non-sterile gloves before manipulating the system. Standard 100% Data collection: observation/self-audit
To reduce the incidence of CAUTI by maintaining a closed system.	All catheters must be connected to a sterile closed drainage system or valve. Standard 100% Data collection: observation
To ensure patients and relatives are informed and educated about catheter management	All patients and carers are aware of the need to: -Decontaminate their hands; -Keep the system closed. Standard 100% Data collection: direct patient questioning of patients and carers.

References:

- Al-Habdan, I. et al** (2003) Assessment of nosocomial urinary tract infections in orthopaedic patients: a prospective and comparative study using two different catheters. *International Surgery*; 88: 3, 152-154.
- Ball, A.J. et al** (1987) Bladder irrigation with chlorhexidine for the prevention of urinary infection after transurethral operations: a prospective controlled study. *Journal of Urology*; 138: 491-494.

Brosnahan, J. et al (2004) Types of urethral catheters for management of short-term voiding problems in hospitalised adults. (Cochrane Review). The Cochrane Library; (Issue 1). Chichester: Wiley.

Burke, J.P. et al (1983) Evaluation of daily meatal care with poly-antibiotic ointment in the prevention of urinary catheter-associated bacteriuria. *Journal of Urology*; 129; 331-334.

Burke, J.P. et al (1981) Prevention of catheter-associated urinary tract infections. Efficacy of daily meatal care regimens. *The American Journal of Medicine*; 70: 655-658.

Chaiban, G. et al (2000) A rapid method of impregnating endotracheal tubes and urinary catheters with gendine: a novel antiseptic agent. *Journal of Antimicrobial Chemotherapy*; 55: 1, 51-56.

Cho, Y.W. et al (2003) Gentamicin-releasing urethral catheter for short-term catheterization. *Journal of Biomaterials Science, Polymer Edition*; 14: 9, 963-972.

Classen, D.C. et al (1991a) Prevention of catheter-associated bacteriuria: clinical trial of methods to block three known pathways of infection. *American Journal of Infection Control*; 19: 136-142.

Classen, D.C. et al (1991b) Daily meatal care for the prevention of catheter-associated bacteriuria: results using frequent applications of poly-antibiotic cream. *Infection Control and Hospital Epidemiology*; 12: 157-162.

Cleland, V. et al (1971) Prevention of bacteriuria in female patients with indwelling catheters. *Nursing Research*; 20: 309-318.

Cornia, P.B. et al (2003) Computer-based order entry decreases duration of indwelling urinary catheterisation in hospitalised patients. *American Journal of Medicine*; 114: 404-407.

Cox, F. et al (1966) Neomycin-polymyxin prophylaxis of urinary-tract infection associated with indwelling catheters. *Antimicrobial Agents and Chemotherapy*; 6: 165-168.

Darouche, R.O. et al (1999) Efficacy of antimicrobial-impregnated bladder catheters in reducing catheter-associated bacteriuria: a prospective, randomized, multicenter clinical trial. *Urology*; 54: 6, 976-981.

Davies, A.J. et al (1987) Does instillation of chlorhexidine into the bladder of catheterized geriatric patients help reduce bacteriuria? *Journal of Hospital Infection*; 9: 72-75.

Desautels, R.F. (1962) Technical advances in the prevention of urinary tract infection. *Journal of Urology*; 87: 487-490.

Dieckhaus, K.D., Garibaldi, R.A. (1998) Prevention of catheter-associated urinary tract infections. In: Abrutyn, E. et al (eds). *Saunders Infection Control Reference Service*. Philadelphia, PA: Saunders.

Dunn, S. et al (2000) Management of short term indwelling urethral catheters to prevent urinary tract infections. A Systematic Review. Adelaide: Joanna Briggs Institute for Evidence Based Nursing and Midwifery.

Gaonkar, T.A. et al (2003) Evaluation of the antimicrobial efficacy of urinary catheters impregnated with antiseptics in an in vitro urinary tract model. *Infection Control and Hospital Epidemiology*; 24: 7, 506-513.

Garibaldi, R.A. et al (1982) An evaluation of daily bacteriologic monitoring to identify preventable episodes of catheter-associated urinary tract infections. *Infection Control*; 3: 466.

Garibaldi, R.A. et al (1980) Meatal colonisation and catheter associated bacteriuria. *New England Journal of Medicine*; 303: 316-318.

Garibaldi, R.A. et al (1974) Factors predisposing to bacteriuria during indwelling urethral catheterisation. *New England Journal of Medicine*; 291: 215-218.

Gentry, H., Cope, S. (2005) Using silver to reduce catheter-associated urinary tract infections. *Nursing Standard*; 19: 50, 51-54.

Getliffe, K.A. et al (2000) The dissolution of urinary catheter encrustation. *British Journal of Urology International*; 85: 60-64.

Getliffe, K.A. (1994) The use of bladder wash-outs to reduce urinary catheter encrustation. *British Journal of Urology*; 73: 696-700.

Gilliespie, W.A. et al (1983) Does the addition of disinfect to urine drainage bags prevent infection in catheterised patients? *Lancet*; 1: 1037-1039.

Gillespie, W.A. et al (1964) Prevention of urinary infections in gynaecology. *British Medical Journal*; 2: 423-425.

Huth, T.S. et al (1992) Randomized trial of meatal care with silver sulfadiazine cream for the prevention of catheter-associated bacteriuria. *Journal of Infectious Diseases*; 165: 14-18.

Johnson, J.R. et al (2006) Systematic review: antimicrobial urinary catheters to prevent catheter-associated urinary tract infection in hospitalized patients. *Annals of Internal Medicine*; 144: 116-126.

Johnson, J.R. et al (1990) Prevention of catheter-associated urinary tract infection with a silver oxide-coated urinary catheter: clinical and microbiologic correlates. *Journal of Infectious Diseases*; 162: 1145-1150.

Jones, M.A., Hasan, A. (1988) Controlled trial of intravesical noxythiolin in the prevention of infection following outflow tract surgery. *British Journal of Urology*; 62: 311-314.

Karchmer, T.B. et al (2000) A randomized crossover study of silver-coated urinary catheters in hospitalized patients. *Archives Internal Medicine*; 160: 3294-3298.

Kass, E.H., Schneiderman, L.J. (1957) Entry of bacteria into the urinary tract of patients with indwelling catheters. *New England Journal of Medicine*; 256: 556-557.

Keerasuntonpong, A. et al (2003) Incidence of urinary tract infections in patients with short-term indwelling urethral catheters: a comparison between a 3-day urinary drainage bag change and no change regimens. *American Journal of Infection Control*; 31: 1, 9-12.

Kennedy, A.P., Brocklehurst, J.C. (1992) Assessment of the use of bladder washouts/instillations in patients with long-term indwelling catheters. *British Journal of Urology*; 70: 6, 610-615.

Kunin, C.M., McCormack, R.C. (1966) Prevention of catheter-induced urinary tract infections by sterile closed drainage. *New England Journal of Medicine*; 274: 1155-1162.

Kunin CM. (1997) *Urinary Tract Infections: Detection, Prevention, and Management* 5th ed. Baltimore MD: Williams and Wilkins.

Lai, K.K. (2002) Use of silver-hydrogel urinary catheters on the incidence of catheter-associated urinary tract infections in hospitalized patients. *American Journal of Infection Control*; 30: 4, 221-225.

Liedberg, H. et al (1990) Refinements in the coating of urethral catheters reduces the incidence of catheter-associated bacteriuria. An experimental and clinical study. *European Urology*; 17: 236-240.

Liedberg, H., Lundeborg, T. (1990) Silver alloy coated catheters reduce catheter-associated bacteriuria. *British Journal of Urology*; 65: 379-381.

Lopez-Lopez, G. et al (1991) Effect of a siliconized latex urinary catheter on bacterial adherence and human neutrophil activity. *Diagnostic Microbiology and Infectious Disease*; 14: 1-6.

Madeo, M. et al The impact of using silver alloy urinary catheters in reducing the incidence of urinary tract infections in the critical care setting. *British Journal of Infection Control*; 5: 1, 21-24.

Maizels, M., Shaeffer, A.J. (1980) Decreased incidence of bacteriuria associated with periodic instillations of hydrogen peroxide into the urethral catheter drainage bag. *Journal of Urology*; 123: 841-845.

Mallett, J., Bailey, C. (eds) (1996) *The Royal Marsden Manual of Clinical Nursing Procedures* (4th ed). Oxford: Blackwell Scientific.

Muncie, H.L.J. et al (1989) Once-daily irrigation of long-term urethral catheters with normal saline. Lack of benefit. *Archives of Internal Medicine*; 149: 2, 441-443.

Newton, T. et al (2002) A comparison of the effect of early insertion of standard latex and silver impregnated latex Foley catheters on urinary tract infections in burn patients. *Infection Control and Hospital Epidemiology*; 23: 4, 217-218.

Nickel, J.C. et al (1989) Incidence and importance of bacteriuria in postoperative short-term urinary catheterisation. *Canadian Journal of Surgery*; 32: 131-132.

Niel-Weise, B.S. et al (2002) Is there evidence for recommending silver-coated urinary catheters in guidelines? *Journal of Hospital Infection*; 52: 2, 81-87.

Pellowe, C.M. et al (2003) Infection control: prevention of healthcare-associated infection in primary and community care. Simultaneously published in: *Journal of Hospital Infection*; 55 (Supplement 2): 1-127 and *British Journal of Infection Control*; **(Supplement) 4: 6, 1-100**. Available at: www.richardwellsresearch.com

Pellowe, C.M. et al (2004) The epic project. Updating the evidence-base for national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England: a report with recommendations. *British Journal of Infection Control*; 5: 6, 10-15. Available at: www.richardwellsresearch.com

Platt, R. et al (1983) Reduction of mortality associated with nosocomial urinary tract infection. *Lancet*; 1: 893-897.

Pomfret, I.J. (1996) Continence clinic. Catheters: design, selection and management. *British Journal of Nursing*; 5: 245-251.

Pratt, R.J. et al (2001) The epic project: developing national evidence-based guidelines for preventing healthcare associated infections. Phase 1: guidelines for preventing hospital-acquired infections. *Journal of Hospital Infection*; 47(Supplement): S1-S-82. Available at: www.richardwellsresearch.com

Riley, D.K. et al (1995) A large randomised clinical trial of a silver-impregnated urinary catheter: lack of efficacy and staphylococcal superinfection. *American Journal of Medicine*; 98: 349-356.

Roe, B.H., Brocklehurst, J.C. (1987) Study of patients with indwelling catheters. *Journal of Advanced Nursing*; 12: 713-718.

Rupp, M.E. et al (2004) Effect of silver-coated urinary catheters: efficacy, cost-effectiveness, and antimicrobial resistance. *American Journal of Infection Control*; 32:8, 445-450.

Saint, S. et al (1998) The efficacy of silver alloy-coated urinary catheters in preventing urinary tract infection: a meta-analysis. *American Journal of Medicine*; 105: 236-241.

Saint, S., Lipsky, B.A. (1999) Preventing catheter-related bacteriuria. Should we? Can we? How? *Archives of Internal Medicine*; 159: 800-808.

Saint, S. et al (2000) The potential clinical and economic benefits of silver alloy urinary catheters in preventing urinary tract infection. *Archives Internal Medicine*; 160: 2670-2675.

Schneeberger, P.M. et al (1992) A randomised study on the effect of bladder irrigation with povidone-iodine before removal of an indwelling catheter. *Journal of Hospital Infection*; 21: 223-229.

Stamm, W.E. (1998) Urinary tract infections. In: Bennett, J.V., Brachman, P.S. (eds). *Hospital Infection* (4th ed). Philadelphia PA: Lippincott-Raven.

Sweet, D.E. et al (1985) Evaluation of H₂O₂ prophylaxis of bacteriuria inpatients with long-term indwelling Foley catheters: a randomised controlled study. *Infection Control*; 6: 263-266.

Talja, M. et al (1990) Comparison of urethral reaction to full silicone, hydrogen-coated and siliconised latex catheters. *British Journal of Urology*; 66: 652-657.

Thibon, P. et al (2000) Randomized multi-centre trial of the effects of a catheter coated with hydrogel and silver salts on the incidence of hospital-acquired urinary tract infections. *Journal of Hospital Infection*; 45: 117-124.

Thompson, R.L. et al (1984) Catheter-associated bacteriuria. Failure to reduce attack rates using periodic instillations of a disinfectant into urinary drainage systems. *Journal of the American Medical Association*; 251: 747-751.

Thornton, G.F., Andriole, V.T. (1970) Bacteriuria during indwelling catheter drainage: II. Effect of a closed sterile draining system. *Journal of the American Medical Association*; 214: 339.

Verleyen, P. et al (1998) Clinical application of the Bardex IC Foley catheter. *European Urology*; 36: 240-246.

Ward, V. et al (1997) *Preventing Hospital-Acquired Infection: Clinical Guidelines*. London: Public Health Laboratory Service.

Warren, J.W. et al (1978) Antibiotic irrigation and catheter-associated urinary-tract infections. *New England Journal of Medicine*; 299: 570-573.

Webster, J. et al (2001) Water or antiseptic for periurethral cleaning before urinary catheterization: a randomized controlled trial. *American Journal of Infection Control*; 29: 6, 389-394.

Wong, E.S., Hooton, T.M. (1983) Guideline for prevention of catheter-associated urinary tract infections. *American Journal of Infection Control*; 11: 1, 28-36.

Copyright Emap 2008 - all rights reserved. All use is subject to our [Terms & Conditions](#) and [Privacy & Cookie Policy](#)