

What to do about recurrent urinary tract infections:

A review of evidence behind emerging therapies

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Background

Recurrent urinary tract infections (rUTIs) can be debilitating for patients and pose an increasing challenge in the primary care setting. An efficient approach enables timely access and effective care for patients. Recent research and pharmaceutical developments have provided new avenues for treating this common condition.

Objective

A narrative review was conducted to provide a targeted overview of contemporary management strategies in rUTIs to assist primary care physicians in managing patients with rUTIs efficiently and effectively.

Discussion

Recurrent urinary tract infections require investigation and risk factor identification. Appropriate patient education in the primary care setting, behavioural modifications and commencement of non-antibiotic treatment might reduce rUTI. Certain patients might require referral to a urologist for consideration of other treatment strategies and further investigation.

RECURRENT URINARY TRACT INFECTIONS

(rUTIs) are a common condition that can be debilitating for patients and pose an increasing challenge in the primary care setting. A narrative review of the available management strategies for rUTIs was conducted and we present an approach to the diagnosis and management of rUTIs. We hope to provide general practitioners (GPs) with a resource to aid initiating management through to when to escalate care to a urologist.

Definitions

Uncomplicated, or 'simple', urinary tract infection (UTI) refers to symptoms isolated to the bladder only.¹ Recurrent UTIs (rUTIs) are defined as two or more episodes of uncomplicated UTI in the preceding six months or three or more episodes diagnosed over one year.²⁻⁶ Pregnant patients are considered to have rUTIs if they have two or more episodes of UTIs during their pregnancy.⁷ rUTIs can impact a patient's quality of life, as persistent symptoms can be debilitating and is a risk factor for antimicrobial resistance and severe infections.^{3,4,6}

The pathophysiology of rUTIs includes bacterial persistence or bacterial reinfection. New infections with the same organism refer to infection persistence, often due to inadequate initial treatment of ongoing nidus of infection. Reinfection refers to infections of the urinary tract with different bacterial

organisms, the same organism after more than two weeks, or a sterile intervening culture.^{3,8} In practice, GPs might be required to exercise judgement as to whether urine microscopy/culture/sensitivities (MCS) returning the same organism is due to bacterial persistence or reinfection. Understanding the prevalence of the causative organisms in rUTIs can be helpful (Table 1). Common causative organisms such as *Escherichia coli* isolated on repeat urine MCS can be due to bacterial reinfection or bacterial persistence, whereas more resistant organisms such as *Pseudomonas aeruginosa* infections are more likely due to persistence.

Prevalence

Urinary tract infections are more common in females, with 30–50% of females experiencing a UTI in their lifetime, as compared with men at 20%.²⁻⁴ One-quarter of women who experience UTI go on to experience rUTI.² Given the prevalence of uncomplicated UTIs in male patients without predisposing risk factors is low (<1% in males aged 15–50 years),² males with simple or rUTIs require further investigation and referral for urology opinion.

Aetiology and risk factors

Urinary tract infection is commonly caused by ascending infection into the bladder via the urethra by rectal bacterial flora that reside in the periurethral area that replicate



Table 1. Causative organisms and risk factors for recurrent urinary tract infections in female and male patients

Female	Male
Causative organisms^{2,10}	
<i>Escherichia coli</i> (70–95%)	<i>Escherichia coli</i> (55%)
<i>Klebsiella pneumoniae</i> (10%)	<i>Klebsiella pneumoniae</i> (7%)
<i>Staphylococcus saprophyticus</i> (5–10%)	<i>Enterococcus faecalis</i> (10%)
<i>Enterococcus faecalis</i> (5%)	<i>Proteus mirabilis</i> (9%)
<i>Proteus mirabilis</i> (4%)	<i>Pseudomonas aeruginosa</i> (7%)
<i>Pseudomonas aeruginosa</i> (1%)	
Risk factors for recurrent UTIs	
Anatomical risk factors in females^{9,11}	Incomplete emptying and high post void residual in males^{9,12}
<ul style="list-style-type: none"> • Shorter urethra • Close proximity between urethral and rectal openings • Anterior vaginal wall prolapse or urethral diverticulum causing incomplete emptying 	<ul style="list-style-type: none"> • Prostate cancer • Benign prostatic hypertrophy • Urethral stricture • Urethral cancer • Phimosis
Postmenopausal female^{6,13}	Reservoirs for infection in males¹²
<ul style="list-style-type: none"> • Oestrogen depletion, causing: <ul style="list-style-type: none"> – Vaginal atrophy (thinning of the vaginal epithelium, reduced elasticity, thinning of vaginal rugae and reduced vaginal secretions) – Atrophic vaginitis (inflammatory process associated with thinning of the vaginal epithelium causing dryness, itchiness, pain, dyspareunia and incontinence) 	<ul style="list-style-type: none"> • Prostatitis
Females in all stages of life^{6,14,15}	
<ul style="list-style-type: none"> • High frequency of sexual intercourse • New or multiple sexual partners • Spermicidal and diaphragm use • Childhood UTI • Maternal UTI (due to possible genetic factors or shared environment exposures) • Patient or family history of blood group antigen non-secretor status (non-secretor females have vaginal epithelium that bind pathogens more avidly, leading to increased risk of colonisation) 	
All patients^{9,12,16}	
<ul style="list-style-type: none"> • Advanced age • Functional deterioration leading to institutionalisation • Conditions that suppress immunity (eg diabetes, chronic illness) • Reservoir for infection <ul style="list-style-type: none"> – Bladder/renal calculi – Urothelial carcinoma of the bladder – Bladder/calyceal diverticulum • Constipation causing inadequate bladder emptying • Poor perineal hygiene (pad use, diarrhoea, incontinence) • Functional risk factors <ul style="list-style-type: none"> – Dysfunctional voiding – Pelvic floor dysfunction • Neurological conditions (eg multiple sclerosis, Parkinson's disease, spinal cord injury, peripheral neuropathy) • Medications (eg SGLT inhibitors) 	
SGLT, sodium–glucose transport protein; UTI, urinary tract infection.	

in the bladder to cause cystitis and urinary symptoms.⁹ Other causes include colovesical fistula, urethral instrumentation and systemic seeding.⁹ Uropathogens causing recurrent rUTIs are similar to those causing acute UTI (Figure 1).²

Risk factors for rUTIs (Figure 1) are similar to risk factors for acute UTI. rUTIs are often caused by various factors such as the impaired host immunity or presence of structural or functional abnormalities of the urinary tract.^{6,9-11} Without due attention and mitigation, patients with risk factors are more likely to develop rUTIs.

Diagnostic evaluation

We present a summary for current diagnostic and management considerations for rUTIs (Figure 1).

Aim

A narrative review guided by expert opinion was conducted to provide a targeted overview of contemporary management strategies for recurrent urinary tract infections.

Results and Discussion

Non-surgical treatment

Behavioural modifications

Most guidelines encourage increasing fluid intake to greater than 1.5 L/day to reduce the number of UTIs and subsequent antibiotic treatment required. This is thought to be mediated by diluting bacterial concentration in the bladder.^{6,17} Other behaviours to reduce risk factors for rUTIs include wiping from front to back after defecation and post-coital urination, which are thought to help by reducing female periurethral colonisation.^{2,3,17} These behavioural modifications, although not strongly supported by evidence, have a limited adverse effect profile, and can offer benefits to some patients. With this in mind, behavioural modifications can be included in the counselling of patients regarding rUTIs, but they do not need to be central in the discussion. Patients should be reassured that their hygiene practices do not place them at fault when experiencing rUTIs.¹⁷

Non-antibiotic treatments

Second-line treatment for rUTIs include non-antimicrobial prophylaxis (Table 2);

these can be used according to the suggested treatment guideline (Figure 2).

Antibiotic treatments

Active UTIs should be treated empirically, with rationalisation to more directed antibiotic treatment once urine culture results become available.⁹ Prevention of future episodes with antibiotic prophylaxis (Table 3) is supported by all guidelines and needs to be offered to those patients suffering from rUTIs.¹⁷ If antibiotic prophylaxis is being considered, prompt urology referral is required to consider other non-antibiotic measures. Prophylactic antibiotics can be associated with more side effects (eg nausea, diarrhoea, vaginal candidiasis) compared to non-antibiotic measures.²⁰ Routine post-treatment urine MCS in asymptomatic patients is not required.⁶

Antibiotics in pregnancy

Recurrent urinary tract infection in pregnancy is defined as having two or more UTIs diagnosed during pregnancy, and occurs in 4–5% of pregnancies.⁷ Asymptomatic bacteria and UTI in pregnancy should be treated and referred to a urologist due to their association with adverse pregnancy outcomes for both mother and child.²⁶ Pregnant patients are more likely to develop pyelonephritis from asymptomatic bacteriuria or UTI. Asymptomatic bacteriuria and UTI in pregnancy is also associated with preterm delivery and low birth rate.^{7,27} Patients should have their acute episode of UTI treated with appropriate antibiotics, and might require post-coital or continuous prophylaxis for the remainder of their pregnancy, with antimicrobial choice dependent on what is safest during pregnancy.⁷

Post-coital prophylaxis

For those with rUTIs clearly associated with sexual activity, a single dose of antibiotic post-intercourse has been found to be just as effective as low-dose, long-term prophylaxis (Table 3).^{2,17,28}

Self-directed prophylaxis

Self-directed prophylaxis is appropriate for patients who are able to initiate testing and treatment when the first symptoms of a UTI present. These patients should be

encouraged to provide a urine sample before commencing treatment.¹ Self-directed prophylaxis is as efficacious as continuous low-dose prophylaxis and has fewer anti-microbial gastrointestinal-related side effects (Table 3).⁹

Continuous low-dose prophylaxis

If patients fail self-directed treatment, low-dose, continuous antibiotic treatment might be required.^{2,28} An initial course of six months with three-monthly review for efficacy and side effect profile is appropriate (Table 3).³ For some patients, treatment can be lifelong, as cessation of continuous antibiotic prophylaxis can lead to rUTI relapse. Antibiotic selection should be based on urine cultures and the local antibiogram,² with a lower dose used compared to that used in the treatment of acute cystitis.⁹ Patient tolerability of antibiotics might also have an impact on the choice of antibiotics selected, and patients need to be monitored for potential adverse reactions to long-term antibiotic use.^{9,29} Only a low number of patients require this type of regimen, and it is best for treatment to be specialist-directed in these cases.

Surgical interventions

It is rare to find a reversible surgical cause in patients with rUTIs, with the exception of pelvic organ prolapse or urinary tract obstruction. Patients with infection refractory to simple measures, as outlined above, should be referred for urologist review, especially in the event of any red flags such as a history of urinary tract surgery including incontinence procedures with mesh, abnormal ultrasound findings or underlying neurology. Surgical interventions aim to remove the underlying infective aetiology.³⁰

Sources of infection can include foreign bodies such as stents, erosive mesh/sutures or renal/bladder calculi, which can all act as nidus for persistence. Most foreign bodies can be removed endoscopically. Urinary fistulae can also be a source of reinfection and can be managed with minimally invasive or open surgery.³⁰ Malignancy can be treated endoscopically with transurethral resection of a bladder tumour. In patients with urinary stasis secondary to bladder outlet obstruction, the cause needs to be accurately identified and treated.^{9,30}

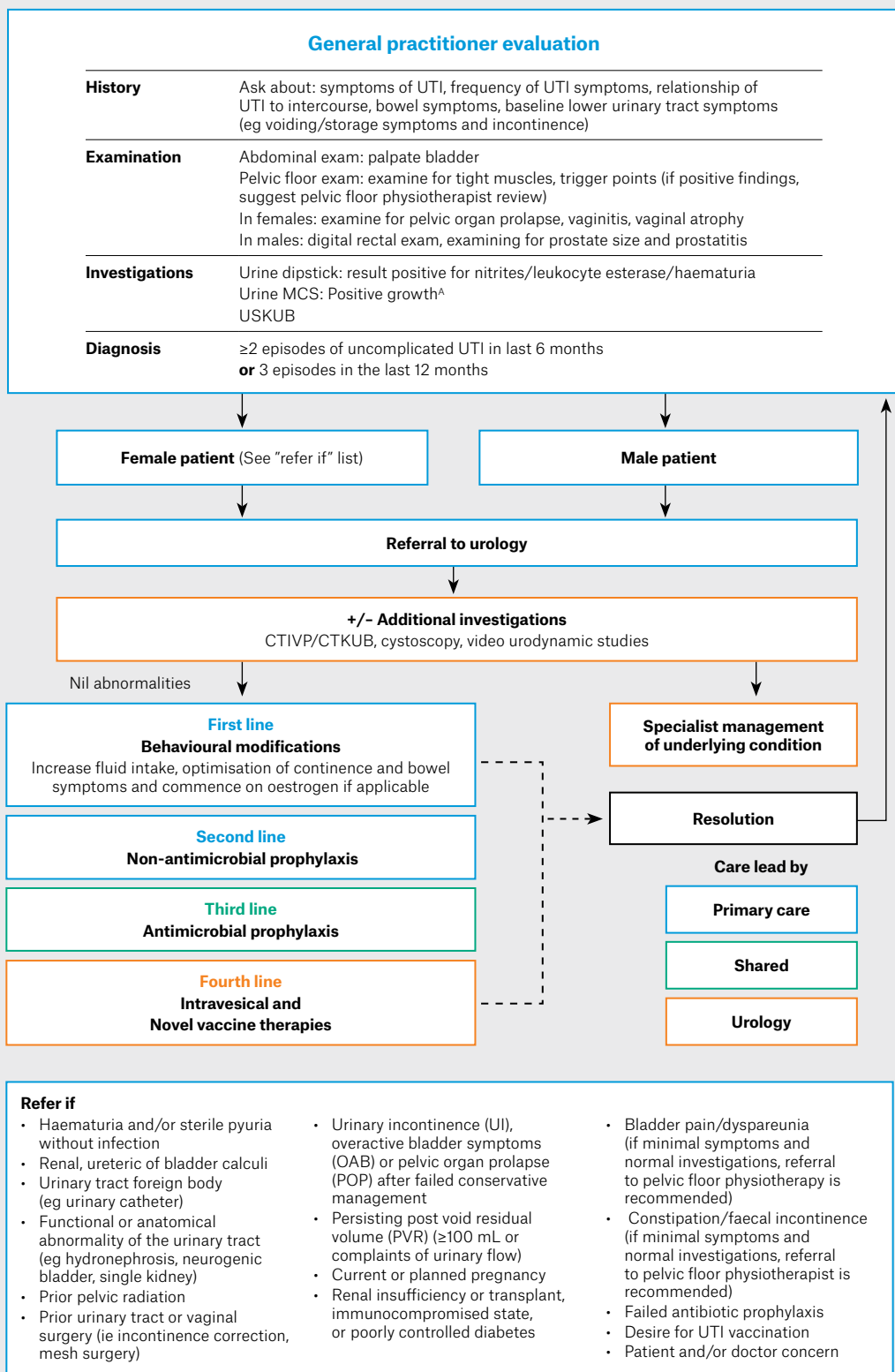


Table 2. Summary of non-antibiotic treatments for recurrent urinary tract infections (rUTIs)

Intervention	Mechanism of action	Side effects	Limitations	Summary	Level of evidence ⁶	Action based on summary of international guidelines ¹⁷
Non-antibiotic (oral and vaginal) therapies						
Vaginal topical oestrogen replacement	Reduced vaginal flora colonisation by depleting glycogen ¹⁸	Vaginal bleeding, vaginal discharge, vagina irritation ¹⁸	<ul style="list-style-type: none"> • Small studies reporting heterogenous treatment schedules¹⁸ 	<ul style="list-style-type: none"> • Found to reduce rUTI in postmenopausal patients¹⁸ • Common misconception regarding cardiovascular and cancer risk associated with long-term oestrogen; however, it is supported for use in postmenopausal patients¹⁷ 	1b	Recommended
Methenamine hippurate	Hydrolysed in the bladder to form formaldehyde for bactericidal effects ^{1,6,19}	Non-specific ¹⁹	<ul style="list-style-type: none"> • Not effective in patients who have renal tract abnormalities or neuropathic bladder¹⁹ 	<ul style="list-style-type: none"> • Effective in preventing UTI when used as prophylaxis,⁶ although long-term benefit is limited with the same rate of recurrence after 1 year^{9,19} • Found to be non-inferior in prevention of UTI compared to daily continuous low-dose prophylaxis²⁰ • Unlike prolonged antibiotics, patients are unlikely to develop resistance over time^{19,20} 	1b	Recommended
Cranberry	Contain proanthocyanins that stop bacterial adherence to bladder mucosa ^{2,4,5,21}	Non-specific gastrointestinal symptoms ²¹	<ul style="list-style-type: none"> • No standardised dosage or duration of treatment reported in literature²¹ • Evidence comparing the efficacy between different forms of cranberry (eg juice, supplementation) is limited²¹ 	<ul style="list-style-type: none"> • Efficacious in women and children only^{4,21} 	1a	Consider
D-mannose	Prevention of bacterial adherence to the bladder mucosa ^{4,22}	Non-specific gastrointestinal symptoms and vaginal irritation ²²	<ul style="list-style-type: none"> • No standardised dosage or duration of treatment in literature²² • Lack of high-quality randomised control trials 	<ul style="list-style-type: none"> • There is contradictory evidence regarding the role of D-mannose in the treatment of rUTI²² 	2	Consider
Probiotics (Most commonly, Lactobacillus)	Converts glucose to lactic acid to acidify urine for a more hostile environment for uropathogens ^{4,5,23}	Non-specific ²³	<ul style="list-style-type: none"> • Possible benefits reported in very small studies with poor methodological reporting and heterogeneity in the type of probiotic used^{6,23} 	<ul style="list-style-type: none"> • No significant benefits supporting use of probiotics compared with placebo or no treatment²³ 	1b	Not supported

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Table 2. Summary of non-antibiotic treatments for recurrent urinary tract infections (rUTIs) (cont'd)

Intervention	Mechanism of action	Side effects	Limitations	Summary	Level of evidence ⁶	Action based on summary of international guidelines ¹⁷
Intravesical and novel therapies						
Intravesical glycosaminoglycan therapy (eg hyaluronic acid and chondroitin sulfate)	Replenishes pre-existing non-stick coating on bladder mucosa ^{3,24}	Mild bladder pain, risk of UTI given catheterisation required	<ul style="list-style-type: none"> Two randomised control trials have shown promising results, with decrease in UTI recurrence, greater time between UTI recurrence, improvement in quality of life^{24,25} 	<ul style="list-style-type: none"> More research required before recommendation for intravesical glycosaminoglycan therapy can be made⁶ 	2	Consider
Immunoactive agents and vaccines	Contains bacterial extracts to stimulate excretion of cytokines from urothelium, and have different routes of administration: oral (OM-89, MV140), vaginal pessary, (MV140), injection (StroVac) ^{4,6}	Dependent on method of administration	<ul style="list-style-type: none"> Restrictions on availability in Australia and requires urologist to coordinate access Low number of studies within each mode of administration⁶ Development of direct vaccine targets to bacterial antigens are currently in testing phase⁴ 	<ul style="list-style-type: none"> Vaccine prophylaxis has been found to be more effective compared to placebo, although there are only a low number of studies within each mode of administration⁶ 	1a	Recommended

If pelvic organ prolapse is the cause of bladder outlet obstruction, surgical treatment might be indicated and a referral to a practitioner who practises in prolapse management, such as a urologist or gynaecologist, is recommended. In males, surgery for benign prostatic enlargement or high bladder neck, which can often affect emptying of the bladder leading to infection, is offered following failure of medical therapy.^{2,9,30} Dilation of strictures or urethroplasty can be considered if urethral stricture disease is suspected to have caused urinary stasis.³⁰ Urinary stasis due to urinary diverticulum might require diverticulectomy. Neuropathic bladder needs to be addressed appropriately to minimise rUTIs and preserve upper tract function.³⁰

Conclusion

rUTIs can be effectively managed in the general practice setting. Early effective management is hoped to reduce side effects, antimicrobial resistance and, most importantly, long-term suffering for these

patients. However, careful history taking, examination and investigation are essential to rule out reversible causes before committing to long-term therapies.

All males with rUTIs should be referred for specialist opinion. Females with uncomplicated rUTIs and without clinical red flags can have their treatment tailored to replace oestrogen in postmenopausal females or trial an oral non-antibiotic agent, both of which are highly effective and low-risk strategies. Referral to urologist can be made for any additional doctor or patient concerns, although a trial of these treatments can improve or even completely resolve patient symptoms while they await specialist review.

Although antibiotic prophylaxis can control rUTIs, proper patient education about preventive measures such as behavioural modifications are necessary to reduce rUTIs, along with simple non-antibiotic measures.

Urology review can be sought for consideration of long-term antibiotic prophylaxis strategies, intravesical therapies and novel immunoactive agents such as vaccines.

Key points

- Patient education, preventive measures and behavioural modifications can reduce rUTIs.
- Identified risk factors for rUTIs should be addressed.
- Referral to a urologist should be made for an assessment if there are concerns about underlying conditions leading to infection or 'red flags' in females and for all males.
- General practitioners should be supported in commencing treatments for rUTIs while a patient is awaiting urological review.
- There is a role of shared care for patients who require escalation of rUTI treatment to long-term prophylactic antibiotics, intravesical therapies and novel immunoactive agents.

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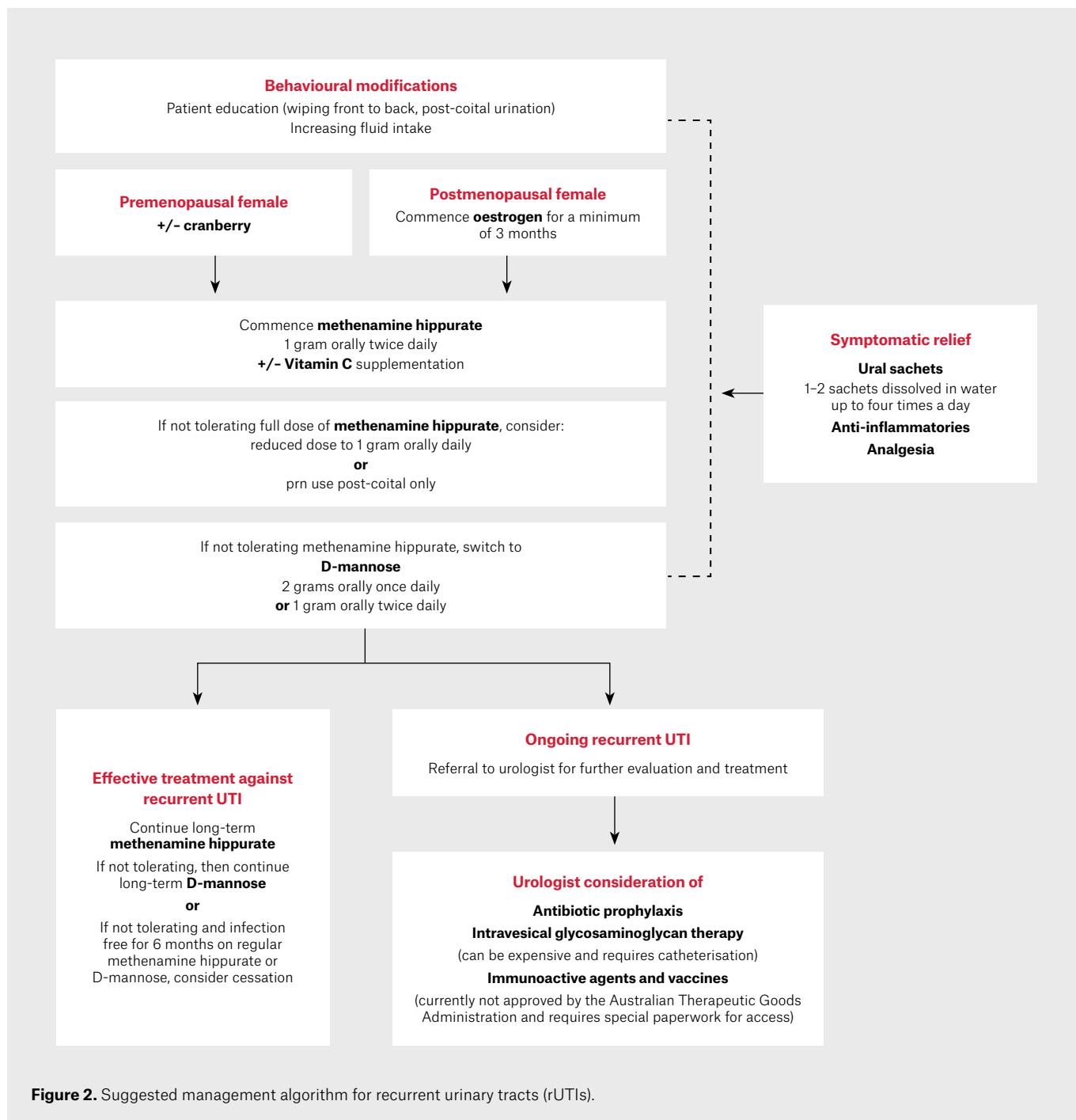


Figure 2. Suggested management algorithm for recurrent urinary tracts (rUTIs).

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Table 3. Treatment regimen for antibiotic prophylaxis²⁸

Treatment regimen	Duration	Antibiotics used	Dosing regimen
Post-coital prophylaxis	<ul style="list-style-type: none"> Indeterminate 	<ul style="list-style-type: none"> Trimethoprim 150 mg orally Cephalexin 250 mg orally Nitrofurantoin 50 mg orally 	<ul style="list-style-type: none"> Single dose of antibiotic within 2 h post intercourse Patients should swap agents every 6 weeks If patients remain infection free for 6 months with post-coital prophylaxis treatment, antibiotic prophylaxis can cease with a trial of post-coital high-dose cranberry
Patient-initiated treatment	<ul style="list-style-type: none"> Standard short course of therapeutic antibiotics 	<ul style="list-style-type: none"> Trimethoprim 300 mg orally daily for 3 days Cephalexin 500 mg orally 12 h for 5 days Nitrofurantoin 100 mg orally 6-hourly for 5 days^A 	<ul style="list-style-type: none"> Patient should provide urine sample for MCS prior to commencement of antibiotics (to monitor for resistance to prescribed antibiotics; not to confirm UTI) Antibiotics should be rationalised once culture results are available (note: commonly used antibiotics will not treat Enterococcus UTI, and amoxicillin is required to treat)
Continuous low-dose prophylaxis	<ul style="list-style-type: none"> 6 months with review at 3 months Potentially life long if relapse after cessation 	<ul style="list-style-type: none"> Trimethoprim 150 mg orally nightly Cephalexin 250 mg orally nightly Nitrofurantoin 50 mg orally nightly^A 	<ul style="list-style-type: none"> Choice of antibiotic depends on previous urine cultures, local antibiogram and patient tolerability

^AMonitoring must be undertaken for long-term nitrofurantoin treatment due to risk of rare adverse effects including pulmonary toxicity, hepatotoxicity and peripheral neuropathy.

MCS, urine microscopy/culture/sensitivities; UTI, urinary tract infection.

References

- American Urological Association. Recurrent uncomplicated urinary tract infections in women: AUA/CUA/SUFU Guideline 2022. American Urological Association, 2022. Available at www.auanet.org/guidelines-and-quality/guidelines/recurrent-uti [Accessed 18 September 2023].
- Concia E, Bragantini D, Mazzaferri F. Clinical evaluation of guidelines and therapeutic approaches in multi drug-resistant urinary tract infections. *J Chemother* 2017;29 Suppl 1:19–28. doi: 10.1080/1120009X.2017.1380397.
- Pat JJ, Witte LPW, Steffens MG, et al. Quality appraisal of clinical guidelines for recurrent urinary tract infections using AGREE II: A systematic review. *Int Urogynecol J* 2022;33(5):1059–70. doi: 10.1007/s00192-022-05089-6.
- Chen YC, Lee WC, Chuang YC. Emerging non-antibiotic options targeting uropathogenic mechanisms for recurrent uncomplicated urinary tract infection. *Int J Mol Sci* 2023;24(8):7055. doi: 10.3390/ijms24087055.
- Naber KG, Bonkat G, Wagenlehner FME. The EAU and AUA/CUA/SUFU guidelines on recurrent urinary tract infections: What is the difference? *Eur Urol* 2020;78(5):645–46. doi: 10.1016/j.eururo.2020.06.032.
- European Association of Urology (EAU). Guidelines: Urological Infections. EAU, 2023. Available at <https://uroweb.org/guidelines/urological-infections/chapter/the-guideline> [Accessed 18 September 2023].
- The American College of Obstetricians and Gynaecologists (ACOG). Urinary tract infections in pregnant individuals. ACOG, 2023. Available at www.acog.org/clinical/clinical-guidance/clinical-consensus/articles/2023/08/urinary-tract-infections-in-pregnant-individuals [Accessed 20 December 2023].
- Dason S, Dason JT, Kapoor A. Guidelines for the diagnosis and management of recurrent urinary tract infection in women. *Can Urol Assoc J* 2011;5(5):316–22. doi: 10.5489/cuaj.687.
- Bono M, Leslie S, Reygaert W. Uncomplicated urinary tract infection. StatPearls Publishing, 2023. Available at www.ncbi.nlm.nih.gov/books/NBK470195/ [Accessed 18 September 2023].
- Magliano E, Grazioli V, Deflorio L, et al. Gender and age-dependent etiology of community-acquired urinary tract infections. *ScientificWorldJournal* 2012;2012:349597. doi: 10.1100/2012/349597.
- Pirpiris A, Chan G, Chaulk RC, Tran H, Liu M. An update on urethral diverticula: Results from a large case series. *Can Urol Assoc J* 2022;16(8):E443–47. doi: 10.5489/cuaj.7650.
- Jiwrajka M, Yaxley W, Perera M, et al. Review and update of benign prostatic hyperplasia in general practice. *Aust J Gen Pract* 2018;47(7):471–75. doi: 10.31128/AFP-08-17-4292.
- Flores S, Hall C. Atrophic vaginitis. StatPearls Publishing, 2023. Available at www.ncbi.nlm.nih.gov/books/NBK564341/ [Accessed 25 December 2023].
- Storme O, Tirán Saucedo J, Garcia-Mora A, Dehesa-Dávila M, Naber KG. Risk factors and predisposing conditions for urinary tract infection. *Ther Adv Urol* 2019;11:1756287218814382. doi: 10.1177/1756287218814382.
- Scholes D, Hooton TM, Roberts PL, Stapleton AE, Gupta K, Stamm WE. Risk factors for recurrent urinary tract infection in young women. *J Infect Dis* 2000;182(4):1177–82. doi: 10.1086/315827.
- Minardi D, d'Anzeo G, Parri G, et al. The role of uroflowmetry biofeedback and biofeedback training of the pelvic floor muscles in the treatment of recurrent urinary tract infections in women with dysfunctional voiding: A randomized controlled prospective study. *Urology* 2010;75(6):1299–304. doi: 10.1016/j.urology.2009.11.019.
- Kwok M, McGeorge S, Mayer-Coverdale J, et al. Guideline of guidelines: Management of recurrent urinary tract infections in women. *BJU Int* 2022;130 Suppl 3:11–22. doi: 10.1111/bju.15756
- Perrotta C, Aznar M, Mejia R, Albert X, Ng CW. Oestrogens for preventing recurrent urinary tract infection in postmenopausal women. *Cochrane Database Syst Rev* 2008;(2):CD005131. doi: 10.1002/14651858.CD005131.pub2.
- Lee BSB, Bhuta T, Simpson JM, Craig JC. Methenamine hippurate for preventing urinary tract infections. *Cochrane Database Syst Rev* 2012;10(10):CD003265. doi: 10.1002/14651858.CD003265.pub3.
- Harding C, Chadwick T, Homer T, et al. Methenamine hippurate compared with antibiotic prophylaxis to prevent recurrent urinary tract infections in women: The ALTAR non-inferiority RCT. *Health Technol Assess* 2022;26(23):1–172. doi: 10.3310/QOIZ6538.
- Williams G, Hahn D, Stephens JH, Craig JC, Hodson EM. Cranberries for preventing urinary tract infections. *Cochrane Database Syst Rev* 2023;4(4):CD001321. doi: 10.1002/14651858.CD001321.pub6.
- Cooper TE, Teng C, Howell M, Teixeira-Pinto A, Jaure A, Wong G. D-mannose for preventing and treating urinary tract infections. *Cochrane Database Syst Rev* 2022;8(8):CD013608. doi: 10.1002/14651858.CD013608.pub2.

23. Schwenger EM, Tejani AM, Loewen PS. Probiotics for preventing urinary tract infections in adults and children. *Cochrane Database Syst Rev* 2015;2015(12):CD008772. doi: 10.1002/14651858.CD008772.pub2.
24. Lazzeri M, Hurlle R, Casale P, et al. Managing chronic bladder diseases with the administration of exogenous glycosaminoglycans: An update on the evidence. *Ther Adv Urol* 2016;8(2):91–99. doi: 10.1177/1756287215621234.
25. Sacco E, Vaccarella L, Bientinesi R, Gandi C, Bassi P. A low-intensity regimen of intravesical administration of hyaluronic acid and chondroitin sulfate for the prevention of recurrent urinary tract infections. 43rd Annual Congress of the Italian Urodynamic Society, Rome, Italy, 13th–15th June 2019. *Neurourol Urodyn* 2019;38 Suppl 2:S4–68. doi: 10.1002/nau.24013.
26. Schneeberger C, Geerlings SE, Middleton P, Crowther CA. Interventions for preventing recurrent urinary tract infection during pregnancy. *Cochrane Database Syst Rev* 2015;2015(7):CD009279. doi: 10.1002/14651858.CD009279.pub3.
27. Australian Government, Department of Health and Aged Care. Asymptomatic bacteriuria. Australian Government, Department of Health, 2019. Available at www.health.gov.au/resources/pregnancy-care-guidelines/part-f-routine-maternal-health-tests/asymptomatic-bacteriuria [Accessed 25 December 2023].
28. Kranz J, Schmidt S, Lebert C, et al. The 2017 update of the German clinical guideline on epidemiology, diagnostics, therapy, prevention, and management of uncomplicated urinary tract infections in adult patients. Part II: Therapy and prevention. *Urol Int* 2018;100(3):271–78. doi:10.1159/000487645.
29. McKertich K, Hanegbi U. Recurrent UTIs and cystitis symptoms in women. *Aust J Gen Pract* 2021;50(4):199–205. doi: 10.31128/AJGP-11-20-5728.
30. Bergamin PA, Kiosoglous AJ. Surgical management of recurrent urinary tract infections: A review. *Transl Androl Urol* 2017;6 Suppl 2:S153–62. doi: 10.21037/tau.2017.06.17.

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