EAU Guidelines on

Urological Infections

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1. INTRODUCTION

1.1 Aim and objectives

This overview represents the updated European Association of Urology (EAU) Guidelines for Urological Infections. The aim is to provide practical recommendations for the prevention and treatment of urinary tract infections (UTIs) and male accessory gland infections. These Guidelines also aim to address the important public health aspects of infection control and antimicrobial stewardship. Separate EAU guidelines are available addressing paediatric urological infections [1] and infections in patients with neurological urinary tract dysfunction [2].

It must be emphasised that clinical guidelines present the best evidence available to the experts, but following guideline recommendations will not necessarily result in the best outcome. Guidelines can never replace clinical expertise when making treatment decisions for individual patients but rather help to focus decisions also taking personal values and references/individual circumstances of patients into account. Guidelines are not mandates and do not purport to be a legal standard of care.

1.2 Panel composition

The EAU Guidelines Panel on Urological Infections consists of an international multi-disciplinary group of urologists with particular expertise in this area, as well as an infectious disease specialist and a clinical microbiologist. All experts involved in the production of this document have submitted potential conflict of interest statements, which can be viewed on the EAU website: http://uroweb.org/guideline/urological-infections/.

1.3 Available publications

A quick reference document, the Pocket Guidelines, is available online and in print. This is an abridged version, which may require consultation together with the full text version. Several scientific publications are also available. All documents are accessible through the EAU website: http://uroweb.org/guideline/urological-infections/. An EAU Guidelines App for iOS and Android devices is also available containing the Pocket Guidelines, interactive algorithms and calculators, clinical decision support tools, guidelines cheat sheets and links to the extended guidelines.

1.4 Publication history

The Urological Infections Guidelines were first published in 2001. This 2026 document presents a limited update of the 2025 publication.

1.4.1 Summary of changes

For the 2026 Urological Infections Guidelines new and relevant evidence was identified, collated and appraised through a structured assessment of the literature for sections 3.17 and 3.18.2.h. This resulted in the inclusion of 36 additional studies across the Guidelines. Key changes include:

- Update of the recommendations in Section 3.4.3.d: Summary of evidence and recommendations for the diagnostic evaluation of cystitis.
- Update of the recommendations in Section 3.4.4.d: Summary of evidence and recommendations for antimicrobial therapy for cystitis.
- Addition of a new chapter on the diagnosis and treatment of fungal urinary tract infections: 3.17 Fungal urinary tract infection.
- Update of the evidence and recommendations on periprocedural antibiotic prophylaxis for prostate biopsy in Section 3.18.3: Summary of evidence and recommendations for peri-procedural antibiotic prophylaxis.
- Review and update of antibiotic dosages where appropriate.

2. METHODS

2.1 Introduction

For the 2026 Urological Infections Guidelines, new and relevant evidence was identified, collated and appraised through a structured assessment of the literature for the current prostate biopsy section as well as a new section addressing fungal urinary tract infection. Broad and comprehensive literature searches covering these sections were carried out. Databases searched included Medline, EMBASE and the Cochrane Libraries. The time frames covered, and the number of unique records identified, retrieved and screened for relevance for each section were:

Section	No. of unique records	Search time frame
3.17 Fungal urinary tract infection	1,295	Unrestricted - July 2025
3.18.2.h Prostate biopsy	159	May 2024 - June 2025

Detailed search strategies are available online: https://uroweb.org/guidelines/urological-infections/publications-appendices.

Recommendations within the Guidelines are developed by the Panels to prioritise clinically important care decisions. The strength of each recommendation is determined by the balance between desirable and undesirable consequences of alternative management strategies, the quality of the evidence (including certainty of estimates), and the nature and variability of patient values and preferences. This decision process, which can be reviewed in the strength rating forms which accompany each guideline statement, addresses the following key elements:

1. the overall quality of the evidence that exists for the recommendation [3];
2. the magnitude of the effect (individual or combined effects);
3. the certainty of the results (precision, consistency, heterogeneity and other statistical or study related factors);
4. the balance between desirable and undesirable outcomes; and
5. the impact and certainty of patient values and preferences on the intervention.

Strong recommendations typically indicate a high degree of evidence quality and/or a favourable balance of benefit to harm and patient preference. Weak recommendations typically indicate availability of lower quality evidence and/or equivocal balance between benefit and harm and uncertainty or variability of patient preference [4].

Additional methodology information and a list of associations endorsing the EAU Guidelines can be found in the online: https://uroweb.org/eau-guidelines/methodology-policies.

2.2 Review

This document was subject to independent peer review prior to publication in 2026.

3. THE GUIDELINE

3.1 Classification

Urinary tract infections (UTIs) encompass a wide spectrum of clinical and pathological conditions affecting various parts of the urinary tract. Each condition has its own unique epidemiology, natural history and diagnostic considerations. A precise distinction is crucial as it significantly impacts treatment and prognosis. Therefore, standardised terminology is essential for effective communication on this subject. Various classification systems of UTI exist. The most widely used systems are from the Centres for Disease Control and Prevention (CDC) [5], the Infectious Diseases Society of America (IDSA) [6], the European Society of Clinical Microbiology and Infectious Diseases (ESCMID) [7], and the United States Food and Drug Administration (FDA) [8, 9]. Current guidelines often differentiate between uncomplicated and complicated UTIs with some modifications. According to these definitions, uncomplicated UTIs occur in healthy, non-pregnant women, while all other UTIs

fall into the category of complicated UTIs. This classification is straightforward, yet it carries inherent risks, as it can significantly affect initial patient management and treatment selection.

The Guidelines Panel propose a new classification scheme for UTIs aimed at enhancing consistency in clinical practice and providing a comprehensive framework for understanding various clinical presentations. The proposed classification no longer uses the terms 'uncomplicated' and 'complicated.' Instead, it emphasises the difference between localised and systemic UTIs identified by clinical signs and symptoms (see Figure 1 and Table 1).

The definitions are as follows (Figure 1):

1. **Localised UTI** (i.e. cystitis): A cystitis without any signs and symptoms of systemic infection in either sex.
2. **Systemic UTI:** An infection with signs and symptoms of systemic infection with or without localised symptoms originating from any site in the urinary tract in either sex.

According to the new definition, UTIs can manifest as either localised (i.e. cystitis) or systemic (e.g. pyelonephritis, prostatitis, etc.) infection. Both conditions may be accompanied by risk factors that increase the likelihood of a challenging clinical course and jeopardise treatment success. Clinicians must be aware of these risk factors and should address them accordingly.

This definition enables medical practitioners to distinguish between a localised UTI that can generally be treated on an outpatient basis and a more complex systemic UTI that may necessitate blood sampling, imaging (e.g. ultrasound, cross-sectional imaging), intravenous antimicrobial treatment and hospitalisation.

Figure 1: Classification of UTI

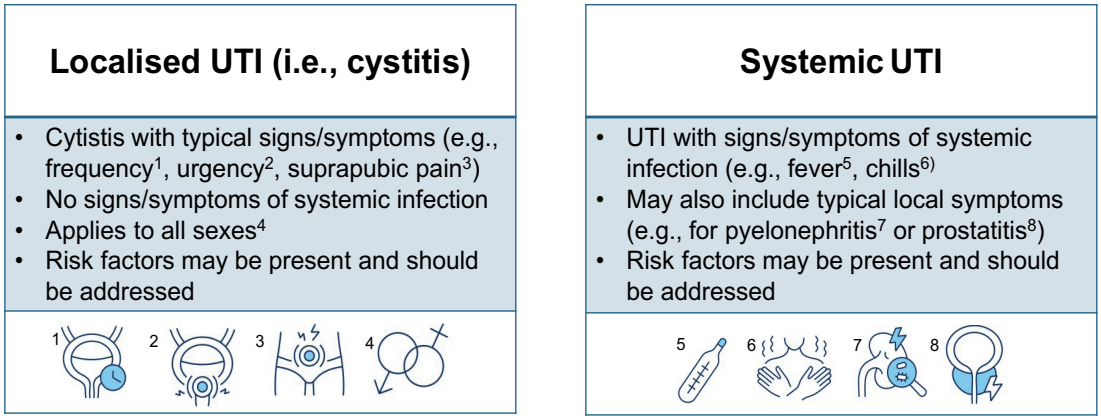


Table 1: Localised and systematic signs and symptoms of UTI

Localised UTI[1]	**Systemic UTI[1,2]**
Dysuria (pain, burning, stinging)	Fever or hypothermia
Urgency	Rigors, shaking chills
Frequency	Delirium
Incontinence	Hypotension
Urethral purulence	Tachycardia
Pressure or cramping in the lower abdomen	Costovertebral angle pain/tenderness

1. *Recent onset of these localised and/or systemic signs and symptoms.*
2. *These signs and symptoms are possibly caused by a systemic UTI, but there may also be alternative explanations.*

*3.1.1 **Risk factors***

When managing UTIs, it is essential to consider risk factors that may predispose patients to a severe clinical course or treatment failure. Factors such as urinary tract abnormalities, the presence of urinary catheters, previous antibiotic treatment, and underlying health conditions (e.g. diabetes, renal impairment, and neurological disorders) can significantly influence the outcome of UTIs. Importantly, in the proposed classification male sex not considered as a risk factor, as it lacks support from contemporary literature. Table 2 provides a clear overview of risk factors for clinicians. By identifying and addressing these risk factors early in the treatment process, clinicians can optimise patient care and improve treatment outcomes.

Table 2: UTI Risk Factors*

<table>
<tr><td>Infants</td><td>Immunocompromised state</td><td rowspan="2">Male sex
• Prostatic involvement (e.g. benign prostatic obstruction, chronic bacterial prostatitis)</td></tr>
<tr><td>Geriatric or frail patients</td><td>Significant post void residual volume</td></tr>
<tr><td rowspan="2">Anatomic or functional abnormalities of the urinary tract</td><td>Neurourological disease</td><td rowspan="3">Female sex
• Pregnancy
• Pelvic organ prolapse</td></tr>
<tr><td>Previous antibiotic use</td></tr>
<tr><td>Indwelling urinary catheters</td><td>Resistant organisms</td></tr>
<tr><td>Stones</td><td>Urinary tract obstruction</td><td>Recent instrumentation</td></tr>
</table>

** Both localised and systemic UTIs may be accompanied by risk factors that increase the likelihood of a challenging clinical course and jeopardise treatment success. Clinicians must be aware of these risk factors to adjust treatment if necessary.*

3.2 Antimicrobial Stewardship

Although the benefits to patients of antibiotic use are clear, overuse and misuse have contributed to the growing problem of resistance amongst uropathogenic bacteria, which is a serious threat to public health [10, 11]. In acute care hospitals, 20-50% of prescribed antibiotics are either unnecessary or inappropriate [12]. In response, a worldwide initiative seeks to incorporate antimicrobial stewardship programmes in healthcare [13]. Antimicrobial stewardship aims to reduce unnecessary antibiotic use, optimise clinical outcomes and ensure cost-effective therapy whilst minimising unintended consequences of antimicrobial use such as healthcare associated infections including *Clostridioides difficile*, toxicity, selection of virulent organisms and emergence of resistant bacterial strains [14].

Stewardship programmes have two main sets of actions. The first set mandates the use of recommended care at the patient level conforming to guidelines. The second set describes strategies to achieve adherence to the mandated guidance. These include persuasive actions such as education and feedback, together with restricting availability linked to local formularies. A Cochrane review of effectiveness of interventions to improve antibiotic prescribing practices for hospital inpatients, updated in 2017, found high-certainty evidence that such interventions are effective in increasing adherence with antibiotic policy leading to reduced antibiotic treatment duration and that it may also reduce hospital stay. The review found no evidence that reduced antibiotic usage increased mortality [15].

The important components of antimicrobial stewardship programmes are [16]:

- regular training of staff in best use of antimicrobial agents;
- adherence to local, national or international guidelines;
- regular ward visits and consultation with infectious diseases physicians and clinical microbiologists;
- audit of adherence and treatment outcomes; and
- regular monitoring and feedback to prescribers of their performance and local pathogen resistance profiles.

A 2016 systematic review of evidence for effectiveness of various antimicrobial stewardship interventions in healthcare institutions identified 145 studies of nine stewardship objectives. Guideline-driven empirical therapy using a restricted choice of antibiotics and including de-escalation, intravenous to oral switch, therapeutic drug monitoring and bedside consultation resulted in a 35% (95% CI 20-46%) relative risk reduction (RRR) in mortality. Use of de-escalation (tailoring to a narrower spectrum agent) showed a RRR of 56% (95% CI 34-70%) in mortality [17].

To facilitate local initiatives and audit, a set of valid, reliable and applicable indicators of the quality of antibiotic use in the treatment of hospitalised patients with complicated UTI was developed [18]. The use of this set of indicators in the Netherlands appeared to result in shortened hospital stay [19]. A literature search of PubMed from April 2014 [17] to February 2017 identified no further randomised controlled trials (RCTs) relating to stewardship programmes for UTIs. Studies to provide high-quality evidence of effectiveness of stewardship programmes in urology patients are urgently needed.

3.3 Asymptomatic bacteriuria in adults

3.3.1 Background

Urinary growth of bacteria in an asymptomatic individual (asymptomatic bacteriuria, ABU) is common and corresponds to a commensal colonisation [20]. Clinical studies have shown that ABU may protect against superinfecting UTI, therefore, treatment of ABU should only be performed in cases of proven benefit for the patient to avoid the risk of selecting antimicrobial resistance and eradicating a potentially protective ABU strain [21, 22]. The aim of this section is to support the clinician in deciding when ABU should or should not be treated.

3.3.2 Epidemiology, aetiology and pathophysiology

Asymptomatic bacteriuria occurs in an estimated 1-5% of healthy premenopausal females. The prevalence increases to 4-19% in otherwise healthy elderly women and men, 0.7-27% in diabetic patients, 2-10% in pregnant women, 15-50% in institutionalised elderly populations and 23-89% in patients with spinal cord injuries [23]. Asymptomatic bacteriuria in younger men is uncommon, but when detected, chronic bacterial prostatitis must be considered. The spectrum of bacteria in ABU is similar to species found in localised or systemic UTIs, depending on the presence of risk factors (see Sections 3.4 and 3.7).

3.3.3 Diagnostic evaluation

Asymptomatic bacteriuria is defined as bacterial growth of $\geq 10^5$ CFU/mL in a midstream urine sample - confirmed in two consecutive samples in women [24] and in one single sample in men [25] in an individual without urinary tract symptoms. Cystoscopy and/or imaging of the upper urinary tract is not mandatory if the medical history is otherwise without remark. If persistent growth of urease-producing bacteria, e.g. *Proteus mirabilis*, is detected, stone formation in the urinary tract must be excluded [26-28]. In men, a digital rectal examination (DRE) must be performed to investigate the possibility of prostate diseases (see Section 3.11).

3.3.4 Evidence summary

A systematic search of the literature from November 2016 to January 2000 identified 3,582 titles, of which 224 were selected for full text review and 50 were included [29]. For the subgroups of pregnancy, prior to urologic surgeries, postmenopausal women and institutionalised elderly patients, only data from RCTs were included, on which a meta-analysis was performed [29]. For the other subgroups, non-RCTs were also included in the narrative analysis [29]. An update systematic literature search from 1 December 2016 to 1 June 2023 identified 1,503 titles, of which 36 were selected for full text review and 18 were included. The following patient populations were not covered by the systematic review: immunocompromised patients and patients with indwelling catheters. For these groups, the guideline was updated using a structured PubMed search. The evidence question addressed was: What is the most effective management for people with asymptomatic bacteriuria?

3.3.5 Disease management

3.3.5.a Patients without identified risk factors

Asymptomatic bacteriuria does not cause renal disease or damage [30]. Only one prospective, non-randomised study investigated the effect of treatment of ABU in adult, non-diabetic, non-pregnant women [31], and found no difference in the rate of symptomatic UTIs. Moreover, as the treatment of ABU has been proven to be unnecessary in most high-risk patient subgroups, there is panel consensus that the results of these subgroups can also be applied to patients without identified risk factors. Therefore, screening and treatment of ABU is not recommended in patients without risk factors.

3.3.5.b Patients with ABU and recurrent UTI, otherwise healthy

One RCT investigated the effect of ABU treatment in female patients with recurrent symptomatic UTI without identified risk factors [22] and demonstrated that treatment of ABU increases the risk for a subsequent symptomatic UTI episode compared to untreated patients (RR 0.28, 95% CI 0.21-0.38; n = 673). This protective effect of spontaneously developed ABU can be used as part of prevention in female patients with recurrent symptomatic UTI, therefore, treatment of ABU is not recommended.

3.3.5.c Pregnant women

3.3.5.c.1 Is treatment of ABU beneficial in pregnant women?

Twelve RCTs comparing antibiotic treatments of ABU with placebo controls or no treatment [32-43], with various antibiotic doses and regimens were identified: ten published before 1988 and one in 2015. Eleven RCTs (n = 2,002) reported on the rate of symptomatic UTIs [32, 34-42, 44]. Antibiotic treatment significantly reduced the number of symptomatic UTIs compared to placebo or no treatment (average RR 0.22, 95% CI 0.12-0.40).

Six RCTs reported on the resolution of bacteriuria [32-34, 36, 39, 41]. Antibiotic treatment was effective in the resolution of bacteriuria compared to placebo (average RR 2.99, 95% CI 1.65-5.39; n = 716). Eight RCTs reported on the rate of low birthweights [32, 34-37, 40, 43, 44]. Antibiotic treatment was associated with lower rates of low birthweight compared to placebo or no treatment (average RR 0.58, 95% CI 0.36-0.94; n = 1689). Four RCTs reported on the rate of preterm deliveries [40, 41, 43, 44]. Antibiotic treatment was associated with lower rates of preterm delivery compared to placebo or no treatment (average RR 0.34, 95% CI 0.18-0.66; n = 854). Three additional systematic reviews and meta-analyses have reported that treatment of ABU in pregnancy may be associated with a decreased rate of pyelonephritis, low birthweight or preterm delivery [45-47]. However, they also emphasised the low to very low quality of the evidence of the identified studies.

Based on the beneficial maternal and foetal effects of antibiotic treatment, pregnant women should be screened and treated for ABU. However, the panel would like to emphasise that most available studies have low methodological quality and are from the 1960s to 1980s. Diagnostic and treatment protocols and accessibility to medical services have dramatically changed since then. Therefore, the quality of evidence for this recommendation is low. In a newer study of higher methodological quality, the beneficial effects of antibiotic treatment are not as evident [44]. Therefore, it is advisable to consult national recommendations for pregnant women.

3.3.5.c.2 Which treatment duration should be applied to treat ABU in pregnancy?

Sixteen RCTs comparing the efficacy of different antibiotic treatments in pregnant women with ABU were identified [48-63]. Significant heterogeneity was found amongst the studies. Studies compared different antibiotic regimens or the same antibiotic regimens with different durations. The duration of treatment ranged from single-dose to continuous treatment (until delivery). For practical purposes, the grouping strategy used by the previously published Cochrane Review was adopted with some modifications [64]. The following treatment groups were used for comparison:

1. single dose (single day)
2. short course (2-7 days)
3. long course (8-14 days)
4. continuous (until delivery)

Nine studies compared single-dose to short-course treatment [49, 53, 54, 58-63], one study compared single dose to long course treatment [57] and one study compared long course to continuous treatment [50]. As long term and continuous antibiotic treatment is not used in current practice, only studies comparing single dose to standard short course treatment are presented.

3.3.5.c.2.a Single dose vs. short course treatment

Three RCTs reported on the rate of symptomatic UTIs [53, 62, 63] with no significant difference between the two durations (average RR 1.07, 95% CI 0.47-2.47; n = 891). Nine RCTs reported on the rate of ABU resolution [49, 53, 54, 58-63], with no significant difference between the two durations (average RR 0.97, 95% CI 0.89-1.07; n = 1,268). Six RCTs reported on the rate of side effects [49, 53, 58, 59, 61, 62]. Single dose treatment was associated with significantly less side effects compared to short course treatment (average RR 0.40, 95% CI 0.22-0.72; n = 458). Three RCTs reported on the rate of preterm deliveries [53, 55, 63], with no significant difference between the two durations (average RR 1.16, 95% CI 0.75-1.78; n = 814). One RCT reported on the rate of low birthweights [63]. There were significantly more babies with low birthweight in the single-dose duration compared to short-course treatment (average RR 1.65, 95% CI 1.06-2.57; n = 714).

According to the data analysis, single-dose treatment was associated with a significantly lower rate of side effects but a significantly higher rate of low birthweight. A meta-analysis on the use of single-dose fosfomycin trometamol in women with cystitis or ABU reported on a subgroup analysis of pregnant women with ABU [65]. The study identified five RCTs involving 577 patients. The resolution rate of ABU in pregnant women treated with single-dose fosfomycin trometamol was not significantly different from those who received other antibiotics (OR 1.32, 95% CI 0.78-2.22, p = 0.30). Therefore, standard short-course treatment or single-dose fosfomycin

trometamol should be applied to treat ABU in pregnancy; however, it should be emphasised that the overall quality of the scientific evidence backing this recommendation is low.

3.3.5.d Patients with identified risk-factors

3.3.5.d.1 Diabetes mellitus

Diabetes mellitus, even when well regulated, is reported to correlate to a higher frequency of ABU [66]. One RCT demonstrated that eradicating ABU did not reduce the risk of symptomatic UTI and infectious complications in patients with diabetes mellitus. The time to first symptomatic episode was also similar in both groups. Moreover, untreated ABU did not correlate to diabetic nephropathy [67]. Screening and treatment of ABU in well-controlled diabetes mellitus is therefore not recommended. However, poorly regulated diabetes is a risk factor for symptomatic UTI and infectious complications.

3.3.5.d.2 ABU in postmenopausal women

Elderly women have an increased incidence of ABU [68]. Four RCTs compared antibiotic treatment of ABU with placebo controls or no treatment, in a post-menopausal female population, with various antibiotic doses and regimens [69-72]. Women in these studies were mostly nursing home residents, which may bias the results of this analysis. Three RCTs reported on the rate of symptomatic UTIs (average RR 0.71, 95% CI 0.49-1.05; 208 women) and the resolution of bacteriuria (average RR 1.28, 95% CI 0.50-3.24; 203 women) [53, 62, 63], with no significant benefit of antibiotic treatment. Therefore, ABU in post-menopausal women does not require treatment, and should be managed as for premenopausal women.

3.3.5.d.3 Elderly institutionalised patients

The rate of ABU is 15-50% in elderly institutionalised patients [73]. Differential diagnosis of ABU from symptomatic UTI is difficult in the multi-diseased and mentally deteriorated patients and is probably a cause of unnecessary antibiotic treatment [74, 75]. Seven RCTs compared antibiotic treatment of ABU with placebo controls or no treatment in elderly patients, with various antibiotic doses and regimens [69-72, 76-78].

Three RCTs reported on the rate of symptomatic UTIs [69, 71, 76]. Antibiotic treatment was not significantly beneficial in reducing the rate of symptomatic UTIs compared to placebo or no treatment (average RR 0.68, 95% CI 0.46-1.00; n = 210). Six RCTs reported on the resolution of bacteriuria [69, 71, 72, 76-78]. There was no benefit of antibiotic treatment compared to placebo in the resolution of ABU (average RR 1.33, 95% CI 0.63-2.79; n = 328). One RCT compared the rates of incontinence in this patient group before and after the eradication of ABU and found no effect of antibiotic treatment [79]. A subsequent systematic review and meta-analysis of nine RCTs found that antibiotic treatment of ABU in this group was associated with significantly more adverse effects with no clinical benefit [80]. Screening and treatment of ABU is therefore not recommended in this patient group.

3.3.5.d.4 Patients with renal transplants

Two RCTs and two retrospective studies compared the effect of antibiotic treatment to no treatment in renal transplant patients [81-84]. Meta-analysis of the two RCTs did not find antibiotic treatment beneficial in terms of reducing symptomatic UTIs between 12 and 22 months after renal transplantation (RR 0.86, 95% CI 0.51-1.45; n = 200). The two retrospective studies reached the same conclusion. Moreover, no significant differences were found in the rate of ABU clearance, graft loss or change in renal function during long-term follow-up of up to 24 months [81-84].

A further two RCTs [85, 86], one observational study [87] and two systematic reviews and meta-analyses [88, 89] were identified. The first RCT reported that during the first two months following renal transplantation, the incidence of and risk for UTIs (25% vs. 10%, HR 2.8, 95% CI 0.8-9.1, p = 0.07) and pyelonephritis (15% vs. 2.5%, HR 6.5, 95% CI 0.8-54.7, p = 0.08) was higher in patients receiving antibiotic treatment for ABU versus no treatment [85]. In the second RCT, no difference in acute graft pyelonephritis was found between the treatment and no-treatment group (12.2% vs. 8.7%, RR 1.40, 95% CI 0.40-4.87) in the first year after renal transplantation. However, rates of antimicrobial resistance were higher in the treatment group [86]. The first of the two additional meta-analyses reported the same results as the original study [88]. The second meta-analysis of n = 1,353 patients reported ABU incidence rates of 22% in the first month and 32% during the first year after renal transplantation [89]. The analysis did not find a correlation between ABU and acute graft pyelonephritis (OR 1.8, 95% CI 0.78-1.79), a benefit of ABU antibiotic treatment on the risk of UTI (OR 1.08, 95% CI 0.63-1.84) or a change of renal function (mean difference in serum creatinine concentration - 0.03 mg/dL [95% CI 0.15-0.10]) [89].

Therefore, treatment of ABU is not recommended in renal transplant recipients.

3.3.5.d.5 ***Patients with dysfunctional and/or reconstructed lower urinary tracts***

Patients with lower urinary tract dysfunction (LUTD) (e.g. neurogenic lower urinary tract dysfunction [NLUTD]) secondary to multiple sclerosis; spinal cord injury patients; patients with incomplete bladder emptying; patients using clean intermittent catheterisation [CIC]; or patients with reconstructed lower urinary tract including ileal conduits, orthotopic bladder replacement or continent reservoirs frequently become colonised [90, 91]. A systematic review reported ABU prevalence rates ranging from 25 to 86% for intestinal conduits in four studies and from 9.1 to 85% for orthotopic neobladders in nine studies [92]. Studies have shown no long-term benefit in ABU treatment in these patient groups [84, 85, 92]. Moreover, in LUTD patients who do not spontaneously develop ABU, deliberate colonisation with an ABU strain (*Escherichia coli* 83972) has shown a protective effect against symptomatic recurrences [93, 94]. Screening and treatment of ABU in these patient groups is therefore not recommended. If these patient groups develop recurrent symptomatic UTI (see Section 3.5) the potential protective effect of a spontaneously developed ABU against UTI must be considered before any treatment.

3.3.5.d.6 ***Patients with catheters in the urinary tract***

Patients with indwelling or suprapubic catheters and nephrostomy tubes invariably become carriers of ABU, with antibiotic treatment showing no benefit [95]. This is also applicable for patients with ABU and indwelling ureteral stents [96]. Routine treatment of catheter-associated ABU is therefore not recommended. For detailed recommendations see Section 3.8.

3.3.5.d.7 ***Patients with ABU subjected to catheter placements/exchanges***

In patients subjected to uncomplicated placement/exchanges of indwelling urethral catheters, ABU is not considered a risk factor and should not be screened or treated [97]. In patients subjected to placement/exchanges of nephrostomy tubes and indwelling ureteral stents, ABU is considered a risk factor for infectious complications [98].

3.3.5.d.8 ***Immuno-compromised and severely diseased patients, patients with candiduria***

These patient groups must be considered individually, and the benefit of screening and treatment of ABU should be reviewed in each case.

3.3.5.e Prior to urological surgery

In diagnostic and therapeutic procedures not entering the urinary tract, ABU is generally not considered a risk factor, and screening and treatment are not considered necessary. On the other hand, in procedures entering the urinary tract and breaching the mucosa, particularly in endourological surgery, bacteriuria is a definite risk factor for post-operative UTI.

Two RCTs [99, 100] and two prospective non-randomised studies [101, 102] compared the effect of antibiotic treatment to no treatment before transurethral prostate or bladder tumour resections. Antibiotic treatment significantly reduced the number of post-operative symptomatic UTIs compared to no treatment in the meta-analysis of the two RCTs (average RR 0.20, 95% CI 0.05-0.86; n = 167). The rates of postoperative fever and septicaemia were also significantly lower in case of antibiotic treatment compared to no treatment in the two RCTs. One RCT including patients with spinal cord injury undergoing elective endoscopic urological surgeries found no significant difference in the rate of postoperative UTIs between single-dose or 3-5 days' short-term pre-operative antibiotic treatment of ABU [103].

A urine culture must therefore be taken prior to such interventions and in case of ABU, preoperative treatment is recommended.

3.3.5.f Prior to orthopaedic surgery

One RCT (n = 471) and one multicentre cohort study (n = 303) comparing the treatment of ABU with no treatment prior to orthopaedic surgery (hip arthroplasty/hemiarthroplasty or total knee arthroplasty) were identified [104, 105]. Neither of the studies showed a beneficial effect of antibiotic treatment in terms of prosthetic joint infection (3.8% vs. 0% and 3.9% vs. 4.7%, respectively). The cohort study reported no significant difference in the rate of postoperative symptomatic UTI (0.65% vs. 2.7%) [105]. One further RCT investigated the efficacy of preoperative ABU treatment with fosfomycin-trometamol for prevention of early-periprosthetic joint infections (PJI) after hip hemiarthroplasty for fractures. Asymptomatic bacteriuria was not predictive of early-PJI (OR: 1.06, 95% CI 0.33-3.38), and its treatment did not modify early-PJI incidence (OR: 1.03, 95%CI 0.15-7.10) [106]. Furthermore, four additional meta-analyses did not find a benefit for preoperative screening or treatment of ABU prior to orthopaedic surgery [107-110]. Therefore, treatment of bacteriuria is not recommended prior to arthroplasty surgery.

3.3.5.g Prior to cardiovascular surgery

One systematic review and meta-analysis including three retrospective non-randomised studies involving a total of 1,116 patients was identified [111]. The procedures performed were non-valvular coronary artery bypass grafting (42%), valvular replacements (51%) and thoracic aortic surgeries (7%). Preoperative treatment of ABU in 116 patients did not result in significant benefit regarding the rate of SSI compared to no treatment (12.9% vs. 8.2%, p = 0.086). A moderate heterogeneity was observed in the meta-analysis and preoperative treatment of ABU had no significant effect on the rate of infectious complications (OR: 1.38, 95% CI 0.56-3.39). Due to the very low number, retrospective and non-randomised design of the included studies, only limited conclusions can be drawn from this. Further studies with appropriate design and sample size are needed to confirm these findings.

3.3.5.h Pharmacological management

If the decision is taken to eradicate ABU, the treatment should be tailored according to the drug sensibility pattern of the pathogen identified. Treatment should be tailored and not empirical.

3.3.6 Follow-up

There are no studies focusing on follow-up after treatment of ABU.

3.3.7 Summary of evidence and recommendations for the management of ABU

Summary of evidence	**LE**
Treatment of asymptomatic bacteriuria is not beneficial in the following conditions:	
• women without risk factors	3b
• patients with well-regulated diabetes mellitus	1b
• postmenopausal women	1a
• elderly institutionalised patients	1a
• patients with dysfunctional and/or reconstructed lower urinary tracts	2b
• patients with renal transplants	1a
• patients prior to arthroplasty surgeries	1a
• patients prior to cardiovascular surgeries	1b
Treatment of asymptomatic bacteriuria is harmful in patients with recurrent urinary tract infections.	1b
Treatment of asymptomatic bacteriuria is beneficial prior to urological procedures breaching the mucosa.	1a
Treatment of asymptomatic bacteriuria in pregnant women was found to be beneficial by meta-analysis of the available evidence; however, most studies are old. A more recent study reported that untreated or placebo-treated asymptomatic bacteriuria-positive women developed pyelonephritis more frequently than asymptomatic bacteriuria-negative women (2.4% vs 0.6%).	1a

Recommendations	**Strength rating**
Do not screen or treat asymptomatic bacteriuria in the following conditions: • women without risk factors; • patients with well-regulated diabetes mellitus; • post-menopausal women; • elderly institutionalised patients; • patients with dysfunctional and/or reconstructed lower urinary tracts; • patients with renal transplants; • patients prior to arthroplasty surgeries; • patients with recurrent urinary tract infections.	Strong
Do not screen or treat asymptomatic bacteriuria in patients prior to cardiovascular surgeries.	Weak
Screen for and treat asymptomatic bacteriuria prior to urological procedures breaching the mucosa.	Strong
Screen for and treat asymptomatic bacteriuria in pregnant women with standard short course treatment or single dose fosfomycin trometamol*.	Weak

** The panel wishes to emphasise that most available studies have low methodological quality and are from the 1960s to 1980s. Diagnostic and treatment protocols and accessibility to medical services have dramatically changed since then. The quality of evidence for this recommendation is therefore low. In a newer study of higher methodological quality, the beneficial effects of antibiotic treatment are not as evident [44]. Therefore, it is advisable to consult national recommendations for pregnant women.*

3.4 Cystitis in women

3.4.1 Introduction

Cystitis in women is defined as a symptomatic lower urinary tract infection limited to the bladder, in the absence of systemic symptoms or signs such as fever, chills, flank pain, or malaise.

3.4.2 Epidemiology, aetiology and pathophysiology

Nearly half of all women will experience at least one episode of cystitis during their lifetime. Nearly one in three women will have had at least one episode of cystitis by the age of 24 [112]. Risk factors include sexual intercourse, use of spermicides, a new sexual partner, a mother with a history of cystitis, and a history of cystitis during childhood. The majority of cases of cystitis are caused by *E. coli.*

3.4.3 Diagnostic evaluation

3.4.3.a Clinical diagnosis

The diagnosis of cystitis can be made with a high probability based on a focused history of lower urinary tract symptoms (dysuria, frequency and urgency) and the absence of vaginal discharge [113, 114]. In elderly women, genitourinary symptoms are not necessarily related to cystitis [115, 116].

3.4.3.b Differential diagnosis

Cystitis should be differentiated from ABU, which is not considered to be infection, but rather a commensal colonisation, which should not be treated and therefore not screened for, unless it is considered a risk factor in clearly defined situations (see Section 3.3).

3.4.3.c Laboratory diagnosis

In patients presenting with typical symptoms of cystitis urine analysis (i.e. urine culture, dip stick testing, etc.) leads only to a minimal increase in diagnostic accuracy [117]. However, if the diagnosis is unclear, dipstick analysis can increase the likelihood of a cystitis diagnosis [118, 119]. Taking a urine culture is recommended in patients with atypical symptoms, as well as those who fail to respond to appropriate antimicrobial therapy [120, 121].

3.4.3.d Summary of evidence and recommendations for the diagnostic evaluation of cystitis

Summary of evidence	LE
An accurate diagnosis of cystitis in women can be based on a focused history of lower urinary tract symptoms and the absence of vaginal discharge or irritation.	2b

Recommendations	Strength rating
Diagnose cystitis in women who have no other risk factors for systemic urinary tract infections based on: • a focused history of lower urinary tract symptoms (dysuria, frequency and urgency); • the absence of vaginal discharge.	Strong
Use urine dipstick testing for diagnosis of acute cystitis.	Weak
Urine cultures should be done in the following situations: • Suspected systemic urinary tract infection. • Symptoms that do not resolve or recur within four weeks after completion of treatment. • Women who present with atypical symptoms. • Patients at high risk for infection with antimicrobial-resistant pathogens. • Pregnant women.	Strong

3.4.4 Disease management

When deciding on the management of cystitis, several therapeutic options are available. These can be broadly divided into two groups: non-antibiotic treatments and antibiotic treatments. Patient preferences should always be appropriately considered. This is particularly relevant for non-antibiotic strategies, which may involve accepting a higher symptom burden and a slightly increased risk of complications such as pyelonephritis.

3.4.4.a Non-antibiotic treatments for the management of cystitis

3.4.4.a.1 Evidence Summary

In July 2024, an update on the role of nutraceuticals in managing cystitis was conducted, in which 995 abstracts were identified, retrieved and screened for relevance with 44 selected for full-text review. This review resulted in the inclusion of 20 systematic reviews or guidelines based on systematic literature searches and 24 original publications for further analysis in the Guidelines. Among the clinical trials, nine studies evaluated the efficacy of nutraceuticals in managing acute episodes of cystitis, while 16 focused on recurrence prevention. Cranberry extract, either alone or in combination with other compounds, was the most extensively studied nutraceutical. The primary focus was determining which nutraceutical compounds effectively alleviate symptoms during the acute phase of cystitis and reduce recurrence rates in women with acute or recurrent symptomatic cystitis.

3.4.4.a.2 Management of acute cystitis

Treatment with cranberry products

The role of cranberry products in managing acute cystitis was evaluated in a systematic review of three RCTs [122]. In two of those RCTs cranberry juice was used [123, 124], while the third trial utilised encapsulated cranberry powder [125]. In all three RCTs, the proanthocyanidin content varied significantly (from 7.5 to 224mg), and the primary objective of the studies was not assessment of cranberry extract as an acute cystitis treatment. The risk of bias of the included studies was judged as moderate. Hence, the current evidence supporting or opposing the use of cranberry products for managing acute cystitis remains insufficient.

Treatment with D-mannose

The role of D-mannose in managing cystitis symptoms was investigated in a systematic review [126] that included seven studies, two of which were RCTs [127, 128]. One RCT compared the use of D-mannose combined with cranberry and antibiotics to antibiotics alone [127], while the other compared D-mannose alone to antibiotics [128]. Among the non-RCTs, only one study evaluated D-mannose alone, with the remainder testing D-mannose in combination with other compounds [129]. Although this review suggests potential benefits of D-mannose in treating acute cystitis, current evidence remains insufficient to recommend it in this setting, due to the limited data for a detailed analysis of the effects of various doses of D-mannose or its impact when used alone versus in combination with other compounds. Moreover, most of the data originates from uncontrolled studies. Overall, the findings from this systematic review and meta-analysis are based on a very limited number of studies with small sample sizes.

A recent single-centre, randomised, double-blind, placebo-controlled trial examined the efficacy of D-mannose-based dietary supplement (D-mannose, citric acid, prebiotic fibres, Astragalus, and dandelion [DAPAD] complex) for subjective (clinical resolution/response) and objective (midstream bacteriuria) outcomes in women with acute *E. coli* cystitis [130]. This study reported higher clinical and bacteriological resolution rates in the treatment group compared to placebo, with both groups receiving standard care and advice on increased fluid intake. However, despite these findings, due to study limitations and limited evidence, D-mannose cannot yet be recommended in this context.

Treatment with phytotherapeutics

A double-blind, parallel group, randomised, multicentre, non-inferiority phase III trial aimed to determine whether herbal therapy with *Centaurii herba*, *Levistici radix*, and *Rosmarini folium* (BNO 1045) is noninferior to fosfomycin trometamol (FT) in treating acute lower cystitis [131]. Women aged 18 to 70 with typical symptoms of newly diagnosed acute lower cystitis were randomised to BNO 1045 (n = 325) or FT (n = 334) with a corresponding matched placebo. The primary endpoint was the proportion of patients who received additional antibiotics to treat cystitis between days one and 38 ± 3. Between days one and 38, 238 (83.5%) patients in the BNO 1045 group and 272 (89.8%) patients in the FT group received no additional antibiotics. At a 15% noninferiority margin, BNO 1045 was noninferior to FT in treating uncomplicated UTIs (uUTIs) (non-AB rate difference: -6.26%; 95% CI -11.99 to -0.53%; 2-sided p = 0.0014). This study demonstrated the noninferiority of this herbal combination compared to fosfomycin trometamol.

Another RCT evaluated the efficacy of a phytotherapeutical combination of L-Methionine accompanied by *Hibiscus sabdariffa* and *Boswellia serrata* for the treatment of acute episodes of cystitis in women affected by recurrent cystitis [132]. Forty-six patients were enrolled in the phytotherapeutics combination group (Group A), and 47 in the short-term antibiotic treatment (Group B). At the first follow-up (30 days), both groups showed a statistically significant improvement in quality-of-life scores as compared with baseline assessment [Group A: (QoL 94.3 vs. 98.5 p < 0.001); Group B: (QoL 94.5 vs. 98.7 p < 0.001)]. An improvement from baseline was also seen at the second follow-up evaluation after three months [Group A: (QoL 94.3 vs. 99.1 p < 0.001); Group B: (QoL 94.5 vs. 98.1 p < 0.001)]. At the second follow-up visit, a statistically significant difference in QoL was

reported between the two groups (99.1 vs. 98.1; $p < 0.003$) and a transition from cystitis to ABU was observed 12 of 46 (26%) patients in Group A, while no patients in Group B demonstrated ABU ($p = 0.007$). It has been demonstrated that phytotherapeutic combinations are able, in comparison to antibiotic treatment, to improve patients' QoL, reducing symptoms in the acute setting and preventing recurrences. Interestingly, a significantly higher proportion of patients in the phytotherapy group had ABU after three months.

A recent systematic review on herbal medicine for cystitis symptom control highlighted that combinations containing *Centaurii herba*, *Levistici radix*, *Rosmarini folium*, L-methionine, *Hibiscus sabdariffa*, and *Boswellia serrata* show promise for treating women with recurrent cystitis [133].

Treatment with xyloglucan, gelose, hibiscus and propolis

In a multicentre, randomised, parallel group, double-blind, phase IV study, the safety and efficacy of a combination containing xyloglucan-gelose-hibiscus-propolis were investigated as adjuvant therapy to first-line antimicrobials for treatment of cystitis in adults [134]. In this study, the medical device ($n = 20$) or placebo ($n = 20$) were administered orally in combination with an antimicrobial agent (e.g. ciprofloxacin) for five days, then alone for five days and then, beginning on day 30 of the study, for 15 days per month for two months. Xyloglucan/gelose reduced positive urine cultures (defined as a bacterial count $\geq 10^3$ CFU/mL) from 100% of patients at baseline to 0% at day 11, with recurrence in three patients (15%) by day 76. Corresponding results with placebo were all patients had positive urine cultures at baseline reduced to 45% at day 11, with recurrence in 14 patients (70%) by day 76. Xyloglucan/gelose significantly reduced the frequency of urinary incontinence and urgency of micturition compared with placebo (both $p < 0.05$), with symptom resolution in all patients by day 90. These findings were supported by a systematic review and meta-analysis of studies testing this xyloglucan-containing preparation [135]. The primary endpoint was clinical or microbiological success, defined as the complete (cure) and/or non-complete (improvement) resolution of symptoms at the end of treatment, or microbiological resolutions. Three studies were included, recruiting a total of 178 patients. All three studies used placebo as comparator. A statistically significant difference was found in terms of clinical and microbiological resolution between the medical device and the comparator (three RCTs, 178 patients, OR: 0.13; 95% CI: 0.05-0.33; $p < 0.0001$). No clinically significant adverse effects have been reported.

Nonsteroidal anti-inflammatory drugs

The indication for antibiotic therapy should be critically assessed [136]. A number of systematic reviews have compared the effects of primarily symptomatic treatment with nonsteroidal anti-inflammatory drugs (e.g. diclofenac, ibuprofen) [137], D-mannose [126], and phytotherapeutic preparations (e.g. uva ursi, BNO 1045) [136] with immediate antibiotic treatment. Non-antibiotic therapies showed good cure rates; however, in most studies their success rates were lower than those achieved with antibiotic treatment when outcomes such as incomplete resolution, additional antibiotic therapy, or the development of pyelonephritis were taken into account [126, 136, 137]. The use of nonsteroidal anti-inflammatory drugs (ibuprofen and diclofenac) and phytotherapy (uva ursi and BNO 1045) have all been shown to result in a reduction in antibiotic therapy [138-142]. Overall, across all studies, non-antibiotic therapy led to a 63% reduction in antibiotic use [136]. For geriatric patients, there is no evidence regarding symptomatic treatment with nonsteroidal anti-inflammatory drugs. Furthermore, nonsteroidal anti-inflammatory drugs are considered potentially inappropriate medications with associated risks in this age group [143].

3.4.4.a.3 Summary of evidence and recommendations for non-antibiotic management of cystitis

Summary of evidence	LE
An RCT showed that *Centaurii herba*, *Levistici radix* and *Rosmarini folium* alone are effective in relieving acute cystitis symptoms compared to fosfomycin trometamol.	1b
An RCT demonstrated the efficacy of L-methionine combined with *Hibiscus sabdariffa* and *Boswellia serrata* in relieving acute cystitis symptoms, as compared to fosfomycin trometamol.	1b
A combination of xyloglucan, hibiscus and propolis is effective in relieving acute cystitis symptoms and preventing recurrence.	1a
There is contradictory evidence on the efficacy of D-mannose to reduce the number of cystitis episodes.	2

Recommendations	Strength rating
Advise female patients on the possibility of antibiotic-sparing approaches for the treatment and prevention of acute cystitis. Patients should be fully informed on the level of evidence for the various approaches.	Strong
Use non-antibiotic therapy options as an alternative to antibiotic treatment in non-geriatric patients. Shared decision-making with the patients is essential.	Strong

3.4.4.b Antibiotic treatment

Antimicrobial therapy may be considered in women with cystitis, as clinical success is significantly more likely compared to placebo [144]. In non-geriatric patients, non-antibiotic therapy alone should be considered as an alternative to antibiotic treatment. A shared decision-making process with the patients is essential [145].

The choice of antimicrobial therapy should be guided by [113]:

- spectrum and susceptibility patterns of the aetiological pathogens;
- efficacy for the particular indication in clinical studies;
- tolerability and adverse reactions;
- adverse ecological effects;
- costs;
- availability.

According to these principles and the available susceptibility patterns in Europe, oral treatment with fosfomycin trometamol 3g single-dose, pivmecillinam 400mg three times daily for three to five days, and nitrofurantoin (e.g. nitrofurantoin monohydrate/macrocrystals 100mg twice daily for five days) should be considered for first-line treatment when available [146-149].

Alternative antimicrobials include trimethoprim alone or combined with a sulphonamide. Co-trimoxazole (160/800mg twice daily for three days) or trimethoprim (200mg twice daily for five days) should only be considered as drugs of first choice in areas with known resistance rates for *E. coli* of < 20% [150, 151].

Aminopenicillins are no longer suitable for empirical therapy due to worldwide high *E. coli* resistance. Aminopenicillins in combination with a beta-lactamase inhibitor such as ampicillin/sulbactam or amoxicillin/clavulanic acid and oral cephalosporins are not recommended for empirical therapy due to ecological collateral damage, but may be used in selected cases [152, 153].

Important note:
On 11 March 2019, the European Commission implemented stringent regulatory conditions regarding the use of fluoroquinolones due to their disabling and potentially long-lasting side effects [154]. This legally binding decision is applicable in all EU countries. National authorities have been urged to enforce this ruling and to take all appropriate measures to promote the correct use of this class of antibiotics. In cystitis, a fluoroquinolone should only be used when it is considered inappropriate to use other antibacterial agents that are commonly recommended for the treatment of these infections [154].

3.4.4.c Cystitis with risk factors

3.4.4.c.1 Cystitis in pregnancy

Short courses of antimicrobial therapy can also be considered for treatment of cystitis in pregnancy [155], but not all antimicrobials are suitable during pregnancy. In general, penicillins, cephalosporins, fosfomycin, nitrofurantoin (not in case of glucose-6-phosphate dehydrogenase deficiency and during the end of pregnancy), trimethoprim (not in the first trimester), and sulphonamides (not in the last trimester) can be considered.

3.4.4.c.2 Renal insufficiency

In patients with renal insufficiency, the choice of antimicrobials may be influenced by decreased renal excretion. However, most antimicrobials have a wide therapeutic index. No adjustment of dose is necessary until the glomerular filtration rate (GFR) is < 20mL/min, with the exception of antimicrobials with nephrotoxic potential, e.g. aminoglycosides. The combination of loop diuretics (e.g. furosemide) and a cephalosporin is nephrotoxic. Nitrofurantoin is contraindicated in patients with an estimated GFR of less than 30mL/min/1.73m^2, as accumulation of the drug leads to increased side effects as well as reduced urinary tract recovery, with the risk of treatment failure [156].

3.4.4.d Cystitis in men

As localised UTIs are rare in men, robust comparative trials are lacking. For empirical oral treatment of acute uncomplicated cystitis in younger men, pivmecillinam and nitrofurantoin are recommended. For nitrofurantoin, evidence-based data on the optimal treatment duration are lacking, and it should only be used if prostatic involvement has been reliably excluded [157].

3.4.4.e Summary of evidence and recommendations for antimicrobial therapy for cystitis

Summary of evidence	LE
Clinical success for the treatment of cystitis is significantly more likely in women treated with antimicrobials than placebo.	1b
The use of nonsteroidal anti-inflammatory drugs and phytotherapy has resulted in a reduction of antibiotic therapy. Overall, across all studies, non-antibiotic therapy led to a 63% reduction in antibiotic use.	1a
Aminopenicillins are no longer suitable for antimicrobial therapy in cystitis due to negative eco-logical effects, high resistance rates and their increased selection for extended spectrum beta-lactamase (ESBL)-producing bacteria.	3

Recommendations	Strength rating
Prescribe fosfomycin trometamol, pivmecillinam, nitrofurantoin or nitroxoline as first-line treatment for cystitis in women.	Strong
Do not use aminopenicillins or fluoroquinolones to treat cystitis.	Strong

Table 3: Suggested regimens for antimicrobial therapy in cystitis

Antimicrobial	Daily dose	Duration of therapy	Comments
First-line women			
Fosfomycin trometamol	3g SD	1 day	
Nitrofurantoin microcrystal*	50-100mg four times a day	5 days	
Nitrofurantoin monohydrate/ macrocrystals*	100mg b.i.d	5 days	
Nitrofurantoin macrocrystal prolonged release*	100mg b.i.d	5 days	
Pivmecillinam	400mg t.i.d	3-5 days	
Nitroxoline	250mg t.i.d	5 days	
Alternatives			
Cefadroxil	500mg b.i.d	3 days	
Cefpodoxime	100mg b.i.d	3 days	
If the local resistance pattern for *E. coli* ***is < 20%***			
Trimethoprim	200mg b.i.d	5 days	Not in the first trimester of pregnancy
Trimethoprim-sulfamethoxazole	160/800mg b.i.d	3 days	Not in the last trimester of pregnancy
Treatment in men			
Trimethoprim-sulfamethoxazole	160/800mg b.i.d	7 days	

SD = single dose; b.i.d = twice daily; t.i.d = three times daily.

** Recommended in young men without involvement of the prostate (e.g. acute bacterial prostatitis), regarding the duration, there are no evidence-based data for nitrofurantoin.*

3.4.5 *Follow-up*

Routine post-treatment urinalysis or urine cultures in asymptomatic patients are not indicated [23]. In women whose symptoms do not resolve by end of treatment and in those whose symptoms resolve but recur within two weeks, urine culture and antimicrobial susceptibility testing should be performed [158]. For therapy in this situation, one should assume that the infecting organism is not susceptible to the agent originally used. Retreatment with a seven-day regimen using another agent should be considered [158].

3.5 Recurrent cystitis

3.5.1 *Introduction*

Recurrent cystitis is defined by at least three episodes of cystitis/year or two episodes of cystitis in the last six months. Recurrent cystitis negatively impacts patient quality of life leading to a reduction in the quality of social and sexual relationships, self-esteem and capacity for work [159].

3.5.2 *Diagnostic evaluation*

Recurrent cystitis is common. Table 4 outlines the risk factors. Initial diagnosis of recurrent cystitis should be confirmed by urine culture. An extensive routine workup including cystoscopy, imaging and so on is not routinely recommended, because the diagnostic yield is low [160]. However, an extensive routing workup should be performed without delay in atypical cases, for example, if renal calculi, outflow obstruction, interstitial cystitis or urothelial cancer is suspected.

Table 4: Age-related associations of recurrent cystitis in women [73, 115, 161]

Young and premenopausal women	Postmenopausal and elderly women
• Sexual intercourse • Use of spermicide • A new sexual partner • A mother with a history of cystitis • History of cystitis during childhood • Blood group antigen secretory status	• History of cystitis before menopause • Urinary incontinence • Atrophic vaginitis due to oestrogen deficiency • Cystocele • Increased post-void urine volume • Blood group antigen secretory status • Urine catheterisation and functional status • Deterioration in elderly institutionalised women

3.5.3 *Disease management and follow-up*

Prevention of recurrent cystitis includes counselling regarding avoidance of risk factors, non-antimicrobial measures and antimicrobial prophylaxis [158, 162]. These interventions should be attempted in this order. Any urological risk factor must be identified and treated. Significant residual urine should be treated optimally, including by CIC when judged to be appropriate.

3.5.3.a Evidence Summary

A broad literature search with cut-off of 31 May 31 2021 identified 3,604 abstracts, of which 361 were selected for full text review. In a total of 114 systematic reviews or guidelines based on systematic literature searches and 131 original publications were selected for further analysis. A further 18 relevant publications were identified from the references of the reviewed studies. Selected studies were assigned to one of nine subgroups based on the method of prevention. An updated search with cutoff date of 1 June 2022 identified a further 316 abstracts, of which 25 were selected for further analysis. The evidence question addressed was: In women with recurrent symptomatic lower urinary tract infection, what interventions reduce the rate of recurrence?

3.5.3.b Behavioural modifications

Women with recurrent cystitis should be counselled on avoidance of risks (e.g. insufficient hydration, habitual and post-coital delayed urination, wiping from back to front after defecation, douching and wearing occlusive underwear) before initiation of long-term prophylactic drug treatment, although there is limited evidence available regarding these approaches [163, 164]. An open-label RCT found that additional fluid intake of 1.5L per day in premenopausal women with recurrent cystitis who were low-volume drinkers (< 1.5L a day) reduced the number of cystitis episodes and antibiotic usage over a 12-month period [165].

3.5.3.c Non-antimicrobial prophylaxis

3.5.3.c.1 Hormonal replacement

Based on the results of four meta-analyses, topical oestrogen therapy (either as a cream or a pessary) shows a trend towards recurrent cystitis prevention [166-169]. All studies reported that application was superior compared to placebo but was inferior compared to antibiotics. Due to its pharmacokinetics, vaginal admission has no systematic side effects; however, local irritation and minor bleeding can occur. The use of oral oestrogens was not effective for recurrent cystitis prophylaxis compared to placebo. Moreover, the use of oral oestrogens was associated with an unfavourable systematic side effect profile. A single prospective, non-comparative study of 30 premenopausal women with recurrent cystitis on oral contraceptives reported a beneficial effect for additional topical oestrogen therapy [170].

3.5.3.c.2 Immunomodulation

A systematic review and meta-analysis evaluated the effectiveness of immunomodulation in preventing recurrent cystitis [171]. Fourteen comparative studies were included, with a total of 2,822 patients across five substance types (StroVac, OM-89, ExPEC4V, MV140, and Solco-Urovac). The pooled risk ratio from eight placebo-controlled studies on the percentage of patients remaining cystitis-free in the short term (6-12 months) was 1.52 (95% CI 1.05-2.20), indicating that patients treated with immunomodulation were approximately 50% more likely to remain cystitis-free in the short term in comparison to placebo. The number needed to treat (NNT) was 6.45 (95% CI 2.80-64.80). However, there was substantial heterogeneity and a risk of publication bias. A subgroup analysis by substance type suggests that short-term effectiveness in reducing recurrent cystitis compared to placebo varies depending on the agent. Current evidence indicates no significant difference between OM-89, Solco-Urovac and ExPEC4V for short-term cystitis prevention compared to placebo, because the risk ratios favoured the immunomodulatory agents but were not statistically significant. Data for MV140 compared to placebo show a risk ratio of 2.23 (95% CI 1.43-3.47), the largest difference among all included studies, however, this finding is from a single RCT of 146 participants. Three additional cohort studies comparing MV140 with antibiotic therapy demonstrated a significantly higher percentage of cystitis-free patients in the immunomodulatory group.

The review also concluded that cystitis immunomodulatory agents are generally safe, with serious adverse events (AEs) being rare and no reports of AEs leading to death. A pooled analysis found no significant difference in AE incidence rates between immunomodulatory agents and placebo. The most frequently reported AEs were headaches, gastrointestinal disturbances and vaginitis. Immunomodulatory-specific side effects appear to be related to the agent used and method of administration.

Given the low certainty of the available data, the previous strong recommendation has been downgraded to weak. The composition and mechanism of action of individual immunomodulatory agents are sufficiently different such that pooled analyses of results from these disparate trials is likely to result in excessive noise. The panel would therefore recommend further intensive study of the most promising agents in larger high-quality randomised clinical trials using standardised definitions of recurrent cystitis and other outcome measure.

3.5.3.c.3 Prophylaxis with probiotics (Lactobacillus spp.)

Five meta-analyses with differing results and eleven relevant systematic reviews were identified [167, 172-185]. Two meta-analyses reported significant positive effects for recurrent cystitis prevention with effective probiotics compared to placebo [176, 178]. The contradictory results of the four meta-analyses are a result of the analysis of various Lactobacillus strains and various administration regimes, treatment durations and patient populations. Most studies concluded that not all Lactobacillus strains are effective for vaginal flora restoration and recurrent cystitis prevention. The highest efficacy was shown with *L. rhamnosus* GR-1, *L. reuteri* B-54, *L. reuteri* RC-14, *L. casei shirota* and *L. crispatus* CTV-05 [167, 174, 176, 178]. Although meta-analyses including all known Lactobacilli strains did not show a significant treatment benefit [167, 174, 176, 178], sensitivity analysis excluding studies using ineffective strains resulted in a positive treatment effect [176].

Of the eleven systematic reviews, seven concluded that prophylaxis with vaginal probiotics has a beneficial clinical impact for the prevention of recurrent cystitis [168, 169, 172, 175, 177, 179-182, 184]. The available data is too minimal or of too low quality to allow the panel to make recommendations on the route of admission, optimal dosage and treatment duration for probiotic prophylaxis.

3.5.3.c.4 Prophylaxis with xyloglucan, hibiscus and propolis

Preclinical evidence supports the use of xyloglucan in managing recurrent urinary tract infections (rUTIs) by creating a barrier that prevents uropathogenic *E. coli* from adhering to epithelial cells , as demonstrated in models of intestinal and uroepithelial cells [135]. A systematic review and meta-analysis including three RCTs, with data on 178 patients found that the combination of xyloglucan, hibiscus and propolis was effective in preventing recurrent cystitis compared to placebo, showing high patient compliance and a reduction in antibiotic use [135]. A statistically significant difference was found in terms of clinical or microbiological resolution between the combination of xyloglucan, hibiscus and propolis and placebo (OR: 0.13; 95% CI: 0.05-0.33; $p < 0.0001$). Additionally, another review also highlighted the efficacy of this approach in managing recurrent cystitis [186].

3.5.3.c.5 Prophylaxis with Centaurii herba, Levistici radix and Rosmarini folium

An RCT involving 90 patients with cystitis compared antimicrobial therapy alone (control group) with antimicrobial therapy plus a combination of *Centaurii herba*, *Levistici radix* and *Rosmarini folium* for three months (two tablets, three times daily). The frequency rate of recurrent episodes of cystitis in the test group was always lower than in the control group with a statistically significant difference at six months (8.9% vs. 17.8%) and at 12 months (15.5% vs. 35.5%) [187]. This combination has also been tested in pregnant women, showing no teratogenic, embryotoxic effects or developmental defects in infants [188].

3.5.3.c.6 Prophylaxis with cranberry

Seven meta-analyses and several systematic reviews were identified [167, 189-194]. A Cochrane systematic review and meta-analysis found that, when compared with placebo, water or no treatment, cranberry products did not significantly reduce the occurrence of symptomatic cystitis overall or in women with recurrent cystitis [189]. However, six subsequent meta-analyses concluded that consumption of cranberry-containing products may protect against cystitis in certain patient populations [167, 190-194]. The differing outcomes across the meta-analyses can be contributed to the clinical and methodological heterogeneity of the included studies [195]. An RCT of 145 women randomised to high-dose versus low-dose cranberry proanthocyanidin extract reported no significant reduction in the number of symptomatic cystitis episodes between the groups [196]. In another RCT of 46 diabetic postmenopausal women, those randomised to receive 120mg of a highly standardised cranberry extract phytosome showed a significant reduction in cystitis recurrence compared to placebo [197]. Another RCT with 172 adult women with a history of recurrent cystitis comparing high-dose proanthocyanidins (240mg) to placebo reported that cranberry extract was associated with reduced cystitis and prolonged cystitis-free survival [198].

Regarding cranberry formulation, a systematic review indicated that cranberry juice combined with increased fluid intake may reduce cystitis rates and antibiotic use [199]. However, optimal dosing and treatment duration, remain unclear. Nevertheless, another systematic review and meta-analysis of 18 RCTs and two non-RCTs with moderate to low certainty supports the use of cranberry products for symptom relief and reducing antibiotic usage [199]. This study also highlights the potential benefits of increased fluid intake in reducing cystitis rates, emphasising the advantage of cranberry in liquid form [199].

Although the efficacy of cranberry products remains unclear, clinicians may recommend them for recurrent cystitis prevention in women, who are informed of the weak evidence base, due to their favourable benefit to harm ratio. However, there is no clear clinical evidence regarding the appropriate dose and treatment duration.

3.5.3.c.7 Prophylaxis with D-mannose

A meta-analysis including one RCT, one randomised cross-over trial and one prospective cohort study analysed data on 390 patients and found that D-mannose was effective for recurrent cystitis prevention compared to placebo with comparable efficacy to antibiotic prophylaxis [200]. Another systematic review concluded that D-mannose had a significant effect on cystitis, but that further studies were needed to confirm these findings [172]. A further systematic review including 695 patients reported that D-mannose improved quality of life and significantly reduced recurrent cystitis in both catheter and non-catheter users and was effective in reducing the incidence of recurrent cystitis and prolonging cystitis-free periods [201]. However, a Cochrane systematic review including 719 patients was unable to determine whether D-mannose significantly reduced the number of recurrent cystitis episodes when compared to no treatment, other supplements or antibiotics [202]. The overall evidence quality was low.

To determine whether D-mannose taken for six months reduces the proportion of women with recurrent cystitis, experiencing a medically attended cystitis, a two-group (2g daily of D-mannose powder or matched volume of placebo powder), double-blind, randomised, placebo-controlled trial was performed [203]. The primary outcome measure was the proportion of women experiencing at least one further episode of clinically suspected

cystitis for which they sought ambulatory care within six months of study entry. Secondary outcomes included symptom duration, antibiotic use, time to next medically attended cystitis, number of hospital admissions for suspected cystitis and cystitis-related issues. The proportion of participants contacting ambulatory care with a clinically suspected cystitis was 150 of 294 (51.0%) in the D-mannose group and 161 of 289 (55.7%) in the placebo group (risk difference: -5%; 95% CI -13% to 3%; p = 0.26). Estimates were similar in per-protocol analyses, imputation analyses and preplanned subgroups. No statistically significant differences were observed in any secondary outcome measures. In this RCT, daily D-mannose did not reduce the proportion of women with recurrent cystitis in primary care who experienced a subsequent clinically suspected cystitis.

In the context of rising antimicrobial resistance, antibiotic-sparing strategies are increasingly essential for therapeutic and environmental benefits. Patients should be informed about these strategies, and urologists are encouraged to provide accurate information on the use of nutraceuticals in clinical practice, as supported by a broad body of research and data.

3.5.3.c.8 Endovesical instillation

Endovesical instillations of hyaluronic acid (HA) and chondroitin sulphate (CS) have been used for glycosaminoglycan (GAG) layer replenishment in the treatment of interstitial cystitis, overactive bladder, radiation cystitis and for prevention of recurrent cystitis [204]. A meta-analysis (n = 143) based on two RCTs and two non-RCTs found significantly decreased cystitis rates per patient/year (pooled mean difference [MD] -2.56; 95% CI -3.86, -1.26; p < 0.001) and significantly longer mean cystitis recurrence times for HA and HA-CS therapy compared to control treatment (pooled MD 130.05 days; 95% CI 5.84, 254.26; p = 0.04) [205]. The duration of treatment intervention ranged from two to six months and the duration of total follow-up ranged from 12 to 18 months. In addition, subgroup analysis of the two RCTs using HA-CS reported a significantly decreased cystitis rate per patient-year, significantly longer mean cystitis recurrence time and a significantly better pelvic pain and urgency/frequency (PUF) total score. However, 24-hour urinary frequency measured as number of voids in three days were not significantly improved after therapy [205].

Another meta-analysis (n = 800) including two RCTs and six non-RCTs found that, when compared to control treatment, HA, with or without CS, was associated with a significantly lower mean cystitis rate per patient-year and a significantly longer time to cystitis recurrence [206]. Furthermore, HA-CS therapy was associated with significantly greater mean reductions in PUF total and symptom scores, and the percentage of patients with cystitis recurrence during follow-up was also lower [206].

As randomised controlled studies are available only for HA plus CS, the quality of evidence is higher for the combination than for HA alone.

3.5.3.c.9 Methenamine hippurate

A Cochrane review from 2012 based on thirteen studies with high levels of heterogeneity concluded that methenamine hippurate may be effective for preventing cystitis in patients without renal tract abnormalities, particularly when used for short-term prophylaxis [207]. A meta-analysis from 2021 based on six studies found that, although studies showed a trend towards a benefit for methenamine hippurate in prevention of recurrent cystitis, no statistically significant difference was observed between the efficacy of methenamine hippurate and any comparators [208]. A subsequent RCT including 240 women randomised (1:1) to receive once-daily, low-dose antibiotic prophylaxis or twice-daily methenamine hippurate for twelve months reported that the incident rate of patient-reported symptomatic cystitis decreased to 1.38 episodes per person per year for the methenamine hippurate group versus 0.89 episodes per person per year for the antibiotic group. The absolute difference was 0.49, thus confirming that methenamine hippurate was not inferior to antibiotic prophylaxis. The rate of adverse events was similar in both groups and a sustained benefit for both treatment arms was observed at six-months follow-up [209, 210].

3.5.3.d Antimicrobials for preventing recurrent cystitis

3.5.3.d.1 Continuous low-dose antimicrobial prophylaxis and postcoital prophylaxis

Four meta-analyses and numerous systematic reviews and guidelines were identified [169, 211-221]. All available meta-analyses conclude that antibiotic prophylaxis is the most effective approach against cystitis recurrences compared with placebo or no treatment [211-213]. Antimicrobials may be given as continuous low-dose prophylaxis for longer periods or as post-coital prophylaxis. No significant difference was observed in the efficacy of the two approaches. There is no available evidence about the optimal duration of continuous antimicrobial prophylaxis, with studies reporting treatment duration of three to twelve months. After discontinuation of the drug, cystitis tends to recur, especially among those who have had three or more infections annually. After counselling, it is mandatory to offer either continuous low-dose antimicrobial

prophylaxis or postcoital prophylaxis when behavioural modifications and non-antimicrobial measures have failed. The choice of strategy should be individualised based on whether episodes are temporally related to intercourse and on patient preference.

Differences in outcomes between antibiotics did not reach statistical significance. The choice of agent should be based on the local resistance patterns. Regimens include nitrofurantoin 50mg or 100mg once daily, fosfomycin trometamol 3g once weekly, trimethoprim 100mg once daily and, during pregnancy, cephalexin 125mg or 250mg or cefaclor 250mg once daily [158, 222, 223]. Postcoital prophylaxis should be considered in pregnant women with a history of frequent cystitis before onset of pregnancy to reduce their risk of cystitis [224].

3.5.3.d.2 Self-diagnosis and self-treatment

In patients with good compliance, self-diagnosis and self-treatment with a short-course regimen of an antimicrobial agent should be considered [225]. The choice of antimicrobials is the same as for sporadic acute cystitis (Section 3.4.4.4).

3.5.4 Summary of evidence and recommendations for the diagnostic evaluation and treatment of recurrent cystitis

Summary of evidence	LE
Extensive routine workup (e.g. cystoscopy, imaging) has a low diagnostic yield for the diagnosis of recurrent cystitis.	3
Increased water intake is an effective antimicrobial-sparing strategy to prevent recurrent cystitis in premenopausal women at high risk for recurrence who drink low volumes (< 1.5L) of fluids daily.	3
Vaginal oestrogen replacement has shown a trend towards preventing recurrent cystitis in postmenopausal women.	1b
There is limited evidence to suggest that immunomodulatory agents are effective at reducing cystitis recurrence in adult female patients in the short term.	1a
Of the currently available immunomodulatory agents, OM-89 and MV140 are the most widely studied, with MV140 showing the most promising results.	1a
Probiotics containing *L. rhamnosus* GR-1, *L. reuteri* B-54 and RC-14, *L. casei shirota* or *L. crispatus* CTV-05 are effective for vaginal flora restoration and have shown a trend towards prevention of recurrent cystitis.	1b
An RCT showed that *Centaurii herba*, *Levistici radix* and *Rosmarini folium* alone are effective in relieving acute cystitis symptoms compared to fosfomycin trometamol.	1b
An RCT demonstrated the efficacy of L-methionine combined with *Hibiscus sabdariffa* and *Boswellia serrata* in relieving acute cystitis symptoms, as compared to fosfomycin trometamol.	1b
A combination of xyloglucan, hibiscus and propolis is effective in relieving acute cystitis symptoms and preventing recurrence.	1a
Centaurii herba, Levistici radix and *Rosmarini folium* are effective in preventing recurrence and reducing antibiotic use.	1b
Highly standardised cranberry extract phytosome and high-dose proanthocyanidins appear effective in preventing recurrent cystitis.	1b
Current scientific evidence regarding the efficacy of cranberry remedies, in combination with increased water intake, supports their use for the treatment of acute cystitis symptoms and the prevention of recurrence.	1a
An RCT demonstrated the efficacy of D-mannose alone to relieve acute symptoms in acute cystitis compared to cotrimoxazole.	1b
Based on limited evidence intravesical GAG therapy can reduce the number of cases of cystitis per patient per year and prolong the time interval between recurrent cystitis episodes.	2
An RCT demonstrated the noninferiority of twice daily methenamine hippurate to daily antibiotic prophylaxis.	1b
Both continuous low-dose antimicrobial prophylaxis and postcoital antimicrobial prophylaxis have been shown to reduce the rate of recurrent cystitis.	1b
A prospective cohort study showed that intermittent self-start therapy is effective, safe and economical in women with recurrent cystitis.	2b

Recommendations	Strength rating
Diagnose recurrent cystitis by urine culture.	Strong
Do not perform an extensive routine workup (e.g. cystoscopy, full-abdominal ultrasound) in women younger than 40 years of age with recurrent cystitis and no risk factors.	Weak
Advise premenopausal women regarding increased fluid intake, as it might reduce the risk of recurrent cystitis.	Weak
Use vaginal oestrogen replacement in postmenopausal women to prevent recurrent cystitis.	Strong
Use immunomodulatory prophylaxis to reduce recurrent cystitis in women in the context of a well-regulated clinical trial.	Weak
Advise patients on the use of local or oral probiotics containing strains of proven efficacy for vaginal flora regeneration to prevent cystitis.	Weak
Advise patients on the use of a combination of xyloglucan, hibiscus and propolis, or *Centaurii herba*, *Levistici radix* and *Rosmarini folium* to reduce recurrent cystitis episodes and reduce antibiotic use.	Weak
Advise patients on the use of cranberry products for symptom relief in acute cystitis and to prevent recurrence; however, patients should be informed that the quality of evidence underpinning this is low with contradictory findings.	Strong
Use D-mannose to reduce recurrent cystitis episodes, but patients should be informed of the overall weak and contradictory evidence of its effectiveness.	Weak
Use methenamine hippurate to reduce recurrent cystitis episodes in women without abnormalities of the urinary tract.	Strong
Use endovesical instillations of hyaluronic acid or a combination of hyaluronic acid and chondroitin sulphate to prevent recurrent cystitis in patients for which less-invasive preventive approaches have been unsuccessful. Patients should be informed that further studies are needed to confirm the results of initial trials.	Weak
Use continuous or postcoital antimicrobial prophylaxis to prevent recurrent cystitis when non-antimicrobial interventions have failed. Counsel patients regarding possible side effects.	Strong
Consider self-administered short-term antimicrobial therapy for patients with good compliance.	Strong

3.6 Pyelonephritis

3.6.1 ***Diagnostic evaluation***

3.6.1.a Clinical diagnosis

Pyelonephritis is suggested in case of fever (> 38°C), chills, flank pain, nausea, vomiting or costovertebral angle tenderness, with or without the typical symptoms of cystitis [226]. Pregnant women with acute pyelonephritis require special attention, as this type of infection may not only have an adverse effect on the mother with anaemia, renal and respiratory insufficiency, but also on the unborn child with more frequent preterm labour and birth [227].

3.6.1.b Differential diagnosis

It is vital to differentiate as soon as possible between pyelonephritis with or without risk factors, such as obstructive pyelonephritis, as the latter can rapidly lead to urosepsis. This differential diagnosis should be made using the appropriate imaging technique (see Section 3.6.1.d).

3.6.1.c Laboratory diagnosis

Urinalysis, including the assessment of white and red blood cells and nitrite, is recommended for routine diagnosis [228]. In addition, urine culture and antimicrobial susceptibility testing should be performed in all cases of pyelonephritis.

3.6.1.d Imaging diagnosis

Evaluation of the upper urinary tract with ultrasound (US) should be performed to rule out urinary tract obstruction or renal stone disease in patients with a history of urolithiasis, renal function disturbances or a high urine pH [229]. Additional investigations, such as a contrast-enhanced computed tomography (CT) scan or excretory urography should be considered if the patient remains febrile after 72 hours of treatment, or immediately if there is deterioration in clinical status [229]. For diagnosis of complicating factors in pregnant women, US or magnetic resonance imaging (MRI) should be used preferentially to avoid radiation risk to the foetus [229].

3.6.2 *Summary of evidence and recommendations for the diagnostic evaluation of pyelonephritis*

Summary of evidence	LE
Urine culture and antimicrobial susceptibility testing should be performed in all cases of pyelonephritis in addition to urinalysis.	4
A prospective observational cohort study found that radiologic imaging can be applied selectively in adults with systemic UTI without loss of clinically relevant information by using a simple clinical prediction rule.	2b
Additional imaging investigations, such as an unenhanced helical computed tomography, should be carried out if the patient remains febrile after 48-72 hours of treatment or in patients with suspected complications, such as sepsis.	4

Recommendations	Strength rating
Perform urinalysis (e.g. using the dipstick method), including the assessment of white and red blood cells and nitrite, for routine diagnosis.	Strong
Perform urine culture and antimicrobial susceptibility testing in patients with pyelonephritis.	Strong
Perform imaging of the urinary tract to exclude urgent urological disorders.	Strong

3.6.3 *Disease management*

3.6.3.a Outpatient treatment

Fluoroquinolones and cephalosporines are the only antimicrobial agents that can be recommended for oral empirical treatment of pyelonephritis [230]. However, oral cephalosporines achieve significantly lower blood and urinary concentrations than intravenous cephalosporines. Other agents, such as nitrofurantoin, oral fosfomycin and pivmecillinam, should be avoided as there is insufficient data regarding their efficacy [231]. In the setting of fluoroquinolone hypersensitivity or known resistance, other acceptable choices include trimethoprim-sulfamethoxazole (160/800mg) or an oral beta-lactam, if the uropathogen is known to be susceptible. If such agents are used in the absence of antimicrobial susceptibility results, an initial intravenous dose of a long-acting parenteral antimicrobial (e.g. ceftriaxone) should be administered. For acute pyelonephritis, a short outpatient antibiotic course of treatment has been shown to be equivalent to longer durations of therapy in terms of clinical and microbiological success. However, this is associated with a higher recurrence rate of infection within four to six weeks and needs to be tailored to local policies and resistance patterns [232].

3.6.3.b Inpatient treatment

Patients with pyelonephritis requiring hospitalisation should be treated initially with an intravenous antimicrobial regimen, e.g. a fluoroquinolone, an aminoglycoside (with or without ampicillin) or an extended-spectrum cephalosporin or penicillin/tazobactam [233]. Ceftolozane/tazobactam achieved a clinical response rate of over 90% in patients with pyelonephritis [234, 235]. Ceftolozane/tazobactam also demonstrated significantly higher composite cure rates than levofloxacin among levofloxacin-resistant pathogens [236]. Ceftazidime-avibactam combination therapy has been shown to be effective for treating ceftazidime-resistant *Enterobacterales* and *Pseudomonas aeruginosa* UTIs [237].

Novel antimicrobial agents include imipenem/cilastatin, cefiderocol, meropenem-vaborbactam and plazomicin. Imipenem/cilastatin has been investigated in a phase II randomised trial and showed good clinical response rates [238]. Cefatazidime-avibactam and doripenem showed similar efficacy against ceftazidime nonsusceptible pathogens and may offer an alternative to carbapenems in this setting [239]. Meropenem-vaborbactam has been shown to be noninferior to piperacillin-tazobactam in a phase III RCT [240]. Meropenem-vaborbactam was also effective for treating carbapenem-resistant *Enterobacterales*, with cure rates of 65% compared to best available treatment [241]. Once-daily plazomicin was noninferior to meropenem for the treatment of complicated UTIs and acute pyelonephritis caused by *Enterobacterales*, including multidrug-resistant strains [242]. Cefiderocol was noninferior to imipenem/cilastatin for the treatment of complicated UTI in people with multidrug-resistant, Gram-negative infections in a phase II RCT [243].

Carbapenems and novel broad spectrum antimicrobial agents should only be considered in patients with early culture results indicating the presence of multidrug-resistant organisms. The choice between these agents should be based on local resistance patterns and optimised on the basis of drug susceptibility results. In patients presenting with signs of urosepsis, empiric antimicrobial coverage for ESBL-producing organisms is

warranted [244]. Patients initially treated with parenteral therapy who improve clinically and can tolerate oral fluids may transition to oral antimicrobial therapy [245].

3.6.3.c Summary of evidence and recommendations for the treatment of pyelonephritis

Summary of evidence	LE
Fluoroquinolones and cephalosporines are the only microbial agents that can be recommended for oral empirical treatment of pyelonephritis.	1b
Intravenous antimicrobial regimens for pyelonephritis may include a fluoroquinolone, an aminoglycoside (with or without ampicillin) or an extended-spectrum cephalosporin or penicillin.	1b
Carbapenems should only be considered in patients with early culture results indicating the presence of multidrug-resistant organisms.	4
The appropriate antimicrobial should be chosen based on local resistance patterns and optimised on the basis of drug susceptibility results.	3

Recommendations	Strength rating
Treat patients with pyelonephritis not requiring hospitalisation with short-course fluoroquinolones as first-line treatment.	Strong
Treat patients with pyelonephritis requiring hospitalisation with an intravenous antimicrobial regimen initially.	Strong
Switch patients initially treated with parenteral therapy who improve clinically and can tolerate oral fluids to oral antimicrobial therapy.	Strong
Do not use nitrofurantoin, oral fosfomycin and pivmecillinam to treat pyelonephritis.	Strong

Table 5: Suggested regimens for empirical oral antimicrobial therapy in pyelonephritis

Antimicrobial	Daily dose	Duration of therapy	Comments
Ciprofloxacin	500-750mg b.i.d	7 days	Fluoroquinolone resistance should be less than 10%.
Levofloxacin	Standard dosage: 500mg oral q.d High dosage: 500mg oral b.i.d	5 days	
Trimethoprim sulfamethoxazole	160/800mg b.i.d	14 days	If such agents are used empirically, an initial intravenous dose of a long-acting parenteral antimicrobial (e.g. ceftriaxone) should be administered.
Cefpodoxime	200mg b.i.d	10 days	
Ceftibuten	400mg q.d	10 days	

b.i.d = twice daily; q.d = every day.

Table 6: Suggested regimens for empirical parenteral antimicrobial therapy in pyelonephritis

Antimicrobials	Daily dose	Comments
First-line treatment		
Ciprofloxacin	400 mg b.i.d	
Levofloxacin	Standard dosage: 500mg oral q.d High dosage: 500mg oral b.i.d	
Cefotaxime	2 g t.i.d	Not studied as monotherapy in acute pyelonephritis.
Ceftriaxone	Standard dosage: 2g IV q.d High dosage: 2g IV b.i.d	Lower dose studied, but higher dose recommended.

Second-line treatment		
Cefepime	Standard dosage: 1g IV t.i.d or 2g IV b.i.d High dosage: 2g IV t.i.d	Lower dose studied, but higher dose recommended.
Piperacillin/tazobactam	Standard dosage: 4.5g t.i.d High dosage: 4.5g q.i.d prolonged infusion	
Gentamicin	6-7mg/kg q.d	Not studied as monotherapy in acute pyelonephritis.
Amikacin	25-30mg/kg q.d	
Last-line alternatives		
Imipenem/cilastatin	Standard dosage: 0.5g IV q.i.d over 30 minutes High dosage: 1g IV q.i.d over 30 minutes	Consider only in patients with early culture results indicating the presence of multidrug-resistant organisms.
Meropenem	1g t.i.d	
Ceftolozane/tazobactam	1.5g t.i.d	
Ceftazidime/avibactam	2.5g t.i.d	
Cefiderocol	2g t.i.d	
Meropenem-vaborbactam	2g t.i.d	
Plazomicin	15mg/kg o.d	

b.i.d = twice daily; IV = intravenous; t.i.d = three times daily; q.d = every day; q.i.d = four times daily; o.d = once daily.

In pregnant women with pyelonephritis, outpatient management with appropriate parenteral antimicrobials may also be considered, provided symptoms are mild and close follow-up is feasible [246, 247]. In more severe cases of pyelonephritis, hospitalisation and supportive care are usually required. After clinical improvement parenteral therapy can also be switched to oral therapy for a total treatment duration of seven to ten days. In men with febrile UTI, pyelonephritis or recurrent infection, or whenever a complicating factor is suspected, a minimum treatment duration of two weeks is recommended, preferably with a fluoroquinolone, since prostatic involvement is frequent [248].

*3.6.4 **Follow-up***

Post-treatment urinalysis or urine cultures in asymptomatic patients post-therapy are not indicated.

3.7 Systemic urinary tract infections

*3.7.1 **Introduction***

Systemic UTIs are infections that originate from various organs of the urinary tract. In contrast to localised UTIs (i.e. cystitis), these infections typically present with systemic signs and symptoms of infection (see Table 1). Local signs and symptoms of infection may also be present. Examples of systemic UTI include pyelonephritis, acute prostatitis and urosepsis. Catheter-associated UTIs might present as localised as well as systemic infections.

*3.7.2 **Diagnostic evaluation***

3.7.2.a Clinical presentation

Systemic UTI should be suspected in patients presenting with dysuria, urinary frequency, urgency or suprapubic pain, accompanied by fever, chills, flank pain or pelvic/perineal pain or when patients appear clinically unwell. Systemic UTI may also be considered in patients with unexplained fever or sepsis. Evaluation should include a thorough clinical assessment to rule out other potential causes of illness. Physical examination should assess for costovertebral angle tenderness and abdominal or suprapubic tenderness. In females, a pelvic examination may be necessary - particularly when symptoms do not clearly suggest a UTI - to evaluate for cervical motion tenderness or uterine tenderness, which could indicate pelvic inflammatory or sexually transmitted disease. In biological men presenting with pelvic or perineal pain, a digital rectal examination is essential to assess for tenderness or swelling of the prostate, which may suggest acute prostatitis.

3.7.2.b Urinalysis and urine culture

For patients with suspected systemic UTI, urine should be collected for both urinalysis and culture with antimicrobial susceptibility testing.

3.7.2.c Pregnancy testing

Pregnancy testing is recommended for women of childbearing potential when pregnancy cannot be reasonably ruled out based solely on medical history.

3.7.2.d Routine blood tests and blood cultures

Routine blood tests should always be considered in patients presenting with systemic signs and symptoms of infection. Blood cultures are indicated for patients presenting with sepsis or severe illness or when *Staphylococcus aureus* is isolated from the urine. *S. aureus* in urine is a 'marker' of *S. aureus* blood stream infections (SABSI). Patients whose urine tests positive for SABSI have a higher mortality than those without bacteriuria [249] as well as higher rates of recurrence after antibiotic cessation [250].

3.7.2.e Imaging

In patients with systemic UTIs, the primary goal of imaging is to identify underlying conditions that may delay therapeutic response or require intervention (e.g. urinary retention, hydronephrosis and so on) as well as to diagnose potential complications of infection (e.g. renal or perinephric abscess or prostatic abscess). Initial imaging should be performed by ultrasound. In case of hydronephrosis or if obstruction of the upper urinary tract is suspected, cross-sectional imaging (CT, MRI) should be carried out. In severely ill patients and in patients exhibiting persistent clinical symptoms despite 48 to 72 hours of appropriate antimicrobial therapy, cross-sectional imaging (CT, MRI) should be performed as well [251, 252].

3.7.3 General principles of systemic UTI treatment

Empiric antimicrobial therapy should be initiated without delay, with subsequent modifications based on antimicrobial susceptibility testing results. Identified or suspected anatomical abnormalities should be thoroughly evaluated and managed as indicated.

3.7.3.a Choice of antimicrobials

3.7.3.a.1 Empiric antimicrobial therapy

Empiric therapy for systemic UTIs should consider illness severity, resistance risk factors and patient-specific factors [231]. Treatment selection depends on prior urinary isolate susceptibility, patient characteristics (e.g. allergies, tolerability, prior antimicrobial use), local resistance patterns and drug-related factors such as toxicity, interactions, availability and costs. Upon identifying the pathogen's susceptibility profile, the empiric regimen should be adjusted accordingly. Evidence for various systemic UTI regimens is limited, with few options formally evaluated [253, 254].

3.7.3.a.2 Critical illness and/or urinary tract obstruction

In critically ill patients with systemic UTIs, patients worsening on current therapy or patients with suspected urinary tract obstruction, broad-spectrum antimicrobials are recommended. A carbapenem e.g. imipenem (500mg IV every 6 hours) or meropenem (1g IV every 8 hours) is advised to cover ESBL-producing organisms and *Pseudomonas aeruginosa*. Vancomycin or alternatives (daptomycin, linezolid) should be added for MRSA coverage. Broad-spectrum coverage is crucial in critically ill or obstructed cases due to high adverse outcome risks and increasing multidrug-resistant pathogens. If cultures confirm susceptibility, regimens should be narrowed. Advanced options such as beta-lactamase-inhibitor combinations - cefiderocol, plazomicin and parenteral fosfomycin, where available - target some ESBL-producing *Enterobacterales* and certain multidrug-resistant *P. aeruginosa* strains [237, 240, 255-257]. However, given the cost, antibiotic stewardship concerns and limited data, the use of these advanced options is reserved for highly resistant cases. Urine culture and susceptibility results should guide both confirmation and refinement of therapy, prioritising narrow-spectrum agents when possible.

3.7.3.a.3 Outpatients

Outpatient treatment may be appropriate for patients with acute systemic UTIs of mild to moderate severity who can reliably take oral medications. The choice of empiric antimicrobials should consider the risk of multidrug-resistant organisms, particularly ESBL producers. Fluoroquinolones are a key option, offering broad activity, including against *P. aeruginosa*, and high urinary concentrations. Despite rising resistance rates, fluoroquinolones, when suitable, remain effective; ciprofloxacin and levofloxacin are preferred.

3.7.3.a.4 Directed antimicrobial therapy

Regimen selection

Urine culture and antimicrobial susceptibility results should guide tailoring of the antimicrobial regimen. Broad-spectrum empiric treatments can often be replaced with narrower-spectrum agents. Patients initially on parenteral therapy may transition to oral agents once symptoms improve, provided culture results support the switch.

Duration

Antimicrobial therapy duration generally ranges from five to ten days, based on clinical response and selected agent. In general, among hospitalised patients with bloodstream infection, antibiotic treatment for seven days is noninferior to treatment for 14 days [258]. For patients with symptomatic improvement within 48-72 hours, recommended durations are five to seven days for fluoroquinolones, seven to ten days for trimethoprim-sulfamethoxazole [233] and seven to ten days for beta-lactams. If clinical response is slow (no improvement within 48-72 hours), further evaluation for complications or anatomical abnormalities is advised [245, 259]. Extended therapy may be needed for persistent infection sources, such as a non-removable stone. Routine extension of therapy duration is unnecessary in cases of uncomplicated bacteremia without complicating factors, because bacteraemia alone does not worsen prognosis, except for *S. aureus* bacteraemia, addressed separately. Systematic reviews and meta-analyses show similar cure rates with shorter courses (≤ 7 days) for systemic UTIs, mostly based on fluoroquinolone trials comparing five- or seven-day regimens to longer treatments [260-262]. However, in males with systemic UTIs, seven days of antibiotic treatment is inferior to 14 days [262, 263]. Limited data exist for other antibiotics, but beta-lactam studies, primarily with older agents, showed no clear benefit of extending treatment beyond ten days [259, 264].

3.7.3.a.5 Addressing risk factors

In addition to antimicrobial therapy, urinary obstruction should be assessed and managed if present. Patients with anatomical or functional urinary tract abnormalities (e.g. neurogenic lower urinary tract dysfunction, indwelling transurethral catheters, nephrostomy tubes, ureteral stents) may need additional interventions. Effective treatment may require addressing these underlying conditions, because antimicrobials alone may be insufficient [265].

3.7.3.a.6 Follow-up

Symptoms should improve quickly with effective antimicrobial therapy. Outpatients with pyelonephritis require follow-up, either in person or by phone, within 48-72 hours. Further evaluation is advised for patients with worsening symptoms post-initiation of antimicrobial therapy, persistent symptoms after 48-72 hours of appropriate therapy, or recurrence within weeks. This may include abdominal or pelvic imaging (typically cross-sectional imaging) to identify factors delaying recovery. Urine culture and antimicrobial susceptibility testing should also be repeated and therapy adjusted as needed. For those presenting with haematuria, a follow-up urinalysis is recommended several weeks post-treatment to check for persistence.

3.7.4 Summary of evidence and recommendations for the treatment of systemic UTIs

Summary of evidence	LE
Patients with a UTI with systemic symptoms requiring hospitalisation should be initially treated with an intravenous antimicrobial regimen chosen based on local resistance data and previous urine culture results from the patient. The regimen should be tailored on the basis of susceptibility result.	1b
If the prevalence of fluoroquinolone resistance is thought to be < 10% and the patient has contraindications for third-generation cephalosporins or an aminoglycoside, ciprofloxacin can be prescribed as an empirical treatment.	2
In the event of hypersensitivity to penicillin a cephalosporins can still be prescribed, unless the patient has had systemic anaphylaxis in the past.	2
In patients with a systemic UTI, empirical treatment should cover ESBL if there is an increased likelihood of ESBL infection based on prevalence in the community, earlier urine cultures and prior antimicrobial exposure of the patient.	2

Recommendations	Strength rating
Use the following antimicrobials as empirical intravenous treatment for systemic UTI: • Amoxicillin plus an aminoglycoside. • A second-generation cephalosporin plus an aminoglycoside. • A third-generation cephalosporin.	Strong
Use ciprofloxacin, provided that: • The local resistance percentages are < 10%. • The patient has contraindications for third-generation cephalosporins or aminoglycosides. • The patient has a hypersensitivity for beta-lactam antimicrobials.	Strong
Do not use ciprofloxacin or other fluoroquinolones for the empirical treatment of systemic UTI in patients from urology departments or when patients have used fluoroquinolones in the last six months.	Strong
Manage any urological abnormality and/or underlying complicating factors.	Strong

3.8 Catheter-associated UTIs

3.8.1 Introduction

Catheter-associated UTI refers to UTIs occurring in a person whose urinary tract is currently catheterised or has been catheterised within the past 48 hours. The urinary catheter literature is problematic, as many published studies use the term CA-bacteriuria without providing information on what proportion are CA-ABU and CA-UTI, and some studies use the term CA-UTI when referring to CA-ABU or CA-bacteriuria [28].

3.8.2 Epidemiology, aetiology and pathophysiology

Catheter-associated UTIs are the leading cause of secondary healthcare-associated bacteraemia. Approximately 20% of hospital-acquired bacteraemias arise from the urinary tract, and the mortality associated with this condition is approximately 10% [266]. A multistate point-prevalence survey of 11,282 patients across 183 hospitals reported that UTI accounted for 12.9% of healthcare-acquired infections [267]. The incidence of bacteriuria associated with indwelling catheterisation is 3-8% per day [268-272]. The duration of catheterisation is the most important risk factor for the development of a CA-UTI [273, 274]. A systematic review and meta-analysis reported an average CA-UTI incidence of 13.79/1,000 hospitalised patients with a prevalence of 9.33% [275]. This study also demonstrated that patients at high risk for CA-UTI were female, had a prolonged duration of catheterisation, had diabetes and had longer hospital and intensive care unit (ICU) stays [275].

Urinary catheterisation perturbs host defence mechanisms and provides easier access of uropathogens to the bladder. Indwelling urinary catheters facilitate colonisation with uropathogens by providing a surface for the attachment of host-cell-binding receptors recognised by bacterial adhesins, thus enhancing microbial adhesion. In addition, the uroepithelial mucosa is damaged, exposing new binding sites for bacterial adhesins, and residual urine in the bladder is increased through pooling below the catheter bulb [276]. Catheter-associated UTIs are often polymicrobial and caused by multidrug-resistant uropathogens.

3.8.3 Diagnostic evaluation

3.8.3.a Clinical diagnosis

Signs and systemic symptoms compatible with CA-UTI include new onset or worsening of fever, rigors, altered mental status, malaise or lethargy with no other identified cause, as well as flank pain, costovertebral angle tenderness, acute haematuria, pelvic discomfort, and, in those whose catheters have been removed, dysuria, urgent or frequent urination, and suprapubic pain or tenderness [277]. In the catheterised patient, the presence or absence of odorous or cloudy urine alone should not be used to differentiate CA-ABU from CA-UTI [28, 277].

3.8.3.b Laboratory diagnosis

Microbiologically, CA-UTI is defined by microbial growth of $\geq 10^3$ CFU/mL of one or more bacterial species in a single catheter urine specimen or in a midstream voided urine specimen from a patient whose urethral, suprapubic or condom catheter has been removed within the previous 48 hours [28]. In catheterised patients, pyuria is not diagnostic for CA-UTI. The presence, absence or degree of pyuria should not be used to differentiate CA-ABU from CA-UTI. Pyuria accompanying CA-ABU should not be interpreted as an indication for antimicrobial treatment. The absence of pyuria in a symptomatic patient suggests a diagnosis other than CA-UTI [28].

3.8.3.c Summary of evidence table and recommendations for diagnostic evaluation of CA-UTI

Summary of evidence	LE
Patients with indwelling or suprapubic catheters become carriers of ABU, with antibiotic treatment showing no benefit.	1a
In the catheterised patient, the presence or absence of odorous or cloudy urine alone should not be used to differentiate CA-ABU from CA-UTI.	2
Microbiologically, CA-UTI is defined by microbial growth of ≥ 10^3 CFU/mL of one or more bacterial species in a single catheter urine specimen or in a mid-stream voided urine specimen from a patient whose catheter has been removed within the previous 48 hours.	3

Recommendations	Strength rating
Do not carry out routine urine culture in asymptomatic catheterised patients.	Strong
Do not use pyuria as sole indicator for catheter-associated UTI.	Strong
Do not use the presence or absence of odorous or cloudy urine alone to differentiate catheter-associated asymptomatic bacteriuria from catheter-associated UTI.	Strong

3.8.4 Disease management

3.8.4.a Limiting catheterisation and appropriate catheter discontinuation

Indwelling catheters should be placed only when they are clinically indicated, for example, for management of urinary retention or where strict monitoring of fluid balance is required. Catheter restriction protocols are an important part of multi-modal interventions to reduce CA-UTI rates. Nurse-driven protocols in hospitals, as well as community based multimodal targeted infection programmes, have been proven to reduce CA-UTI rates [278, 279]. Adjunctive devices such as electronic reminder systems have also been shown to assist in prompt catheter removal in hospital settings (including non-ICU). A systematic review of nineteen different interventions to reduce UTI in nursing home patients (including catheter discontinuation and limiting catheterisation) reported successful CA-UTI reduction and reduced catheter usage [280]. Another report of over 2,800 patients on a surgical oncology unit found that increasing catheter bundle compliance resulted in a significant reduction in CA-UTI rates [281].

3.8.4.b Urethral cleaning and chlorhexidine bathing

A network meta-analysis of 33 studies (6,490 patients) found no difference in the incidence of CA-UTI comparing the various urethral cleaning methods versus disinfection [282]. The efficacy of chlorhexidine baths (either using 2% chlorhexidine-impregnated cloths or 4% chlorhexidine-based soap) in reducing CA-UTI is debatable. In an RCT of 10,783 ICU patients, no difference in CA-UTI rates were reported between chlorhexidine and control bathing groups [283]. However, a systematic review of fifteen studies involving only ICU patients reported that daily chlorhexidine bathing was associated with a significant reduction in CA-UTI (RR 0.68) [284].

3.8.4.c Alternatives to indwelling urethral catheterisation

Alternatives include intermittent urethral catheterisation (IC) or suprapubic catheterisation. In a systematic review of patients undergoing gynaecological surgery, indwelling catheters were associated with higher rates of symptomatic UTIs compared to IC [285]. A further meta-analysis of postpartum women reported no difference in the incidence of UTI after labour between continuous catheterisation and IC [285]. A prospective cohort study of nursing home residents found that residents with a suprapubic catheter had fewer CA-UTIs and were hospitalised less, but were more likely to be colonised with multidrug-resistant organisms [286].

A Cochrane review found insufficient evidence to assess the value of various policies for replacing long-term urinary catheters on patient outcomes [97]. Another Cochrane review investigating the role of urethral (indwelling or intermittent) versus suprapubic catheterisation in the short term found inconclusive evidence of an effect on UTI rates [287]. For patients with NLUTD, a further systematic review found no randomised or quasi-randomised controlled trials and therefore no conclusions regarding the use of the various types of catheters could be made [288]. Therefore, based on the available literature, while some limited studies show a benefit of IC or suprapubic catheterisation over urethral catheterisation for CA-UTI rates, insufficient evidence is available to recommend those approaches routinely [289].

3.8.4.d Impregnated or coated catheters

Hydrophilic coated catheters have been found to be beneficial for reducing CA-UTI rates. A meta-analysis of seven studies investigating RCTs comparing hydrophilic coated to PVC (standard) catheters for IC found a statistically lower risk ratio (0.84) for the frequency of UTI in the hydrophilic catheter group [290]. A systematic review and practice policy statements on UTI prevention in patients with spina bifida recommended the use of single-use and hydrophilic catheters for IC [291].

Silver-alloy-impregnated catheters have not been associated with reduced CA-UTI rates. A small RCT of 54 ICU patients showed no significant difference in UTI rates between the silver-alloy-impregnated group and the standard silicone-foley-catheter group [292]. In a cohort study of patients undergoing suprapubic catheter placement at the time of pelvic organ prolapsed surgery, a 5% difference in UTI rate at six weeks was noted, although this was not significant [293]. A systematic review of 26 trials (12,422 patients) reported that silver-alloy-coated catheters were not associated with a statistically significant reduction in CA-UTI and were considerably more expensive [294]. However, the same study found that nitrofurazone-impregnated catheters reduce the risk of symptomatic CA-UTI, although this was borderline significant (RR 0.84, 95% CI 0.71- 0.99) [294]. A more recent RCT (214 patients) evaluating the use of nitrofurazone-infused catheters post-renal transplant found no benefit for their use [295]. Additionally, another RCT showed no benefit for the use of silver-alloy-coated indwelling catheters for reduction of UTI in 489 patients with spinal cord injury [296].

From a microbiological perspective, there may be a difference in organisms causing CA-UTI from urethral and suprapubic catheters and therefore urine culture results are important to guide therapy [289].

3.8.4.e Antibiotic prophylaxis for catheter removal or insertion

The issue of whether antibiotic prophylaxis reduce the rate of symptomatic UTI in adults following indwelling bladder catheter removal has been the subject of multiple RCTs. A review and meta-analysis identified seven RCTs with 1,520 participants. Meta-analysis showed overall benefit for use of prophylaxis RR (95%CI) = 0.45 (0.28-0.72); ARR 5.8% (10.5-4.7%) with a number needed to treat (NNT) of 17 [214]. Results for individual trials were inconsistent with five trials including the possibility of no benefit [214]. In an affectional RCT with 172 participants undergoing laparoscopic radical prostatectomy randomised to seven days of ciprofloxacin (n = 80) or no treatment (n = 80) at the time of catheter removal, which occurred at a mean of nine days postoperatively, there was no difference in infective complications recorded at up to four weeks after catheter removal. More isolates obtained from the prophylaxis group (11) were resistant to ciprofloxacin compared to the no-treatment group (3) [215]. With regards to catheter insertion, a systematic review and meta-analysis showed that prophylactic antibiotics reduced the rate of bacteriuria and other signs of infection, such as pyuria, fever and gram-negative isolates in patients' urine in surgical patients who undergo bladder drainage for at least 24 hours postoperatively [297].

3.8.4.f Antibiotic prophylaxis for intermittent self-catheterisation (ISC)

An RCT investigating the effect of antibiotic prophylaxis in patients performing ISC showed that the frequency of symptomatic antibiotic-treated UTI was reduced by 48% using prophylaxis in a cohort of 404 patients performing ISC [298]. However, resistance against the antibiotics used for UTI treatment was more frequent in urinary isolates from the prophylaxis group than in those from the control group at 9-12 months.

While the literature shows some benefit for reduction of CA-UTI by utilising antibiotics, the routine use of antibiotics for such a common procedure in the healthcare setting would result in an increased usage of antimicrobials. As highlighted in some of the RCTs, this strategy is associated with increased antimicrobial resistance. Antibiotic use is the main driving force in the development of antimicrobial resistance. Current antimicrobial stewardship principles would not favour the routine use of antibiotic prophylaxis for either catheter changes or ISC, even when UTIs could be prevented [289].

3.8.4.g Antimicrobial treatment for suspected CAUTI

A urine specimen for culture should be obtained prior to initiating antimicrobial therapy for presumed CA-UTI due to the wide spectrum of potential infecting organisms and the increased likelihood of antimicrobial resistance. The urine culture should be obtained from the freshly placed catheter prior to the initiation of antimicrobial therapy [28]. Based on the global prevalence on infections in urology (GPIU) study, the causative micro-organisms in CA-UTI are comparable with the causative micro-organisms in other cUTIs. Symptomatic CA-UTIs should therefore be treated according to the recommendations for localised and systemic UTIs [299].

Seven days is the recommended duration of antimicrobial treatment for patients with CA-UTI who have prompt resolution of symptoms, and fourteen days of treatment is recommended for those with a delayed response, regardless of whether or not the patient remains catheterised [28]. A five-day regimen of levofloxacin may be considered in patients with CA-UTI who are not severely ill. Data are insufficient to make such a recommendation regarding other fluoroquinolones. With the rise in fluoroquinolone resistance, alternative antimicrobial agents should be selected where possible to start empirical therapy based on local microbiological information. A five-day antibiotic regimen with catheter exchange has been shown in one study to be non-inferior to a 10-day regimen with catheter retention based on clinical cure [300].

A three-day antimicrobial regimen may be considered for women aged ≤ 65 years who develop CA-UTI without upper urinary tract symptoms after an indwelling catheter has been removed. If an indwelling catheter has been in place for two weeks at the onset of CA-UTI and is still indicated, the catheter should be replaced to hasten resolution of symptoms and to reduce the risk of subsequent CA-bacteriuria and CA-UTI. If use of the catheter can be discontinued, a culture of a voided midstream urine specimen should be obtained prior to the initiation of antimicrobial therapy to help guide treatment [28]. Long-term indwelling catheters should not be changed routinely. Follow appropriate practices for catheter insertion and care [301].

3.8.4.h Recommendations for disease management and prevention of CA-UTI

Summary of evidence	LE
A systematic review of nineteen different interventions to reduce UTI including catheter discontinuation and limiting catheterisation in nursing home patients reported successful CA-UTI reduction and reduced catheter usage.	1b
A meta-analysis of seven studies investigating RCTs comparing hydrophilic coated to PVC (standard) catheters for IC found a statistically lower risk ratio (0.84) for the frequency of UTI in the hydrophilic catheter group.	1a
A meta-analysis showed overall benefit for use of prophylaxis for reduction of infective complications after catheter removal. However, results from individual trials were inconsistent with five out of seven trials, including the possibility of no benefit.	1a
A subsequent RCT found no benefit of antibiotic prophylaxis for reduction of infective complications at up to four weeks after catheter removal.	1b

Recommendations	Strength rating
Treat symptomatic catheter-associated UTI according to the recommendations for localised and systemic UTI.	Strong
Take a urine culture prior to initiating antimicrobial therapy in catheterised patients in whom the catheter has been removed.	Strong
Do not treat catheter-associated asymptomatic bacteriuria in general.	Strong
Treat catheter-associated asymptomatic bacteriuria prior to traumatic urinary tract interventions (e.g. transurethral resection of the prostate).	Strong
Replace or remove the indwelling catheter before starting antimicrobial therapy.	Strong
Do not apply topical antiseptics or antimicrobials to the catheter, urethra or meatus.	Strong
Do not use prophylactic antimicrobials to prevent catheter-associated UTIs.	Strong
Do not routinely use antibiotic prophylaxis to prevent clinical UTI after urethral catheter removal.	Weak
The duration of catheterisation should be minimal.	Strong
Use hydrophilic-coated catheters to reduce catheter-associated UTIs.	Strong
Do not routinely use antibiotic prophylaxis to prevent clinical UTI after urethral catheter removal or in patients performing intermittent self-catheterisation.	Weak

3.9 Urosepsis

Section 3.9 is currently under review, and an updated version will be published in the 2027 edition of the Guidelines. In the interim, users are advised to refer to the Surviving Sepsis Campaign Guidelines 2021 from the Society of Critical Care Medicine [302].

3.10 Urethritis

3.10.1 Introduction

Urethritis can be of either infectious or non-infectious origin. Inflammation of the urethra usually presents with subjective symptoms (dysuria, alguria, burning, itching and pain around the distal urethra and external urethral meatus) and clinical signs (urethral discharge, erythema around the external urethral meatus and inguinal lymphadenopathy). These symptoms and signs must be distinguished from those of other infections of the lower urinary tract. Urethral infection is typically spread by sexual contact. The following recommendations are based on the consultation draft of the S3 guideline on urethritis, 'Management of Urethritis in Male Adolescents and Adults' (AWMF registry number 013-099) [303].

3.10.2 Epidemiology, aetiology and pathophysiology

In most cases, urethritis is caused by sexually transmitted bacteria, the most common of which are *C. trachomatis*, *N. gonorrhoeae* and *M. genitalium*. It should be noted that pathogens whose relevance as a cause of urethritis symptoms is questionable or must be determined on a case-by-case basis, such as *U. urealyticum*, *U. parvum* and *M. hominis*, are also frequently detected. Urethral infections with more than one pathogen are common. Empirical antibiotic treatment must therefore take into account the potential effects of targeting the primary pathogen on any coexisting infections. From a therapeutic and clinical point of view, gonorrhoeal urethritis (GU) caused by *Neisseria gonorrhoeae* must be differentiated from non-gonococcal urethritis (NGU). Non-gonococcal urethritis is a non-specific diagnosis that can have many infectious aetiologies. Causative pathogens include *C. trachomatis*, *M. genitalium*, *U. urealyticum* and *Trichomonas vaginalis*. The role of Ureaplasma spp. as urethritis causative pathogens is controversial. Recent data suggests that *U. urealyticum*, but not *U. parvum* is an aetiological agent in NGU [304]. The prevalence of isolated causative pathogens are: *C. trachomatis* 11-50%; *M. genitalium* 6-50%; Ureaplasmas 5-26%; *T. vaginalis* 1-20%; and adenoviruses 2-4% [305].

The causative pathogens either remain extracellularly on the epithelial layer or penetrate into the epithelium (*N. gonorrhoeae* and *C. trachomatis*) and cause pyogenic infection. Although arising from urethritis, chlamydiae and gonococci can spread further through the urogenital tract to cause epididymitis in males or cervicitis, endometritis and salpingitis in females [306].

3.10.3 Diagnostic evaluation

In symptomatic patients the diagnosis of urethritis can be made on the basis of the presence of any of the following criteria [305, 306]:

- Mucoid (watery-clear), mucopurulent (whitish-opaque urethral discharge), or purulent (yellow-green) urethral discharge.
- Gram- or methylene-blue staining of urethral discharge showing inflammation. Five or more polymorphonuclear leucocytes (PMNL) per high power field (HPF) is the historical cut-off for the diagnosis of urethritis. A cut-off of ≥ 2 PMNL/HPF has recently been proposed based on improved diagnostic accuracy [307-310], but this was not supported by other studies [311]. Therefore, in line with the 2016 European Guideline on the management of NGU [305], the use of ≥ 5 PMNL/HPF cut-off is recommended until the benefit of alternative cut-off levels is confirmed.
- The presence of ≥ 10 PMNL/HPF in the sediment from a spun first-void urine sample or a positive leukocyte esterase test in first-void urine.

Evidence of urethral inflammation on the Gram stain of urethral secretions with intracellular gonococci as Gram-negative diplococci indicates GU. Non-gonococcal urethritis is confirmed when staining of urethral secretions indicates inflammation in the absence of intracellular diplococci. Clinicians should always perform point-of-care diagnostics (e.g. Gram staining, first-void urine with microscopy, leukocyte esterase test) when available to obtain objective evidence of urethral inflammation and to guide treatment [305, 306, 312]. Recent studies have shown that processing time of point-of-care diagnostics is highly relevant in terms of patient compliance and real-life applicability [313, 314].

3.10.4 Urethral swab, urinalysis, NAAT

In cases of urethral discharge and suspected GU, a meatal/urethral swab should be taken for microbiological culture and *N. gonorrhoeae* resistance testing. Regardless of the initial classification of urethritis as GU or NGU, a nucleic acid amplification test (NAAT) should be performed to detect *N. gonorrhoeae*, *M. genitalium* and *C. trachomatis* [305, 315]. For molecular genetic diagnosis of *N. gonorrhoeae*, *C. trachomatis* and *M. genitalium* in cases of suspected urethral infection, both meatal/urethral swabs and first-void urine can be used. The sensitivity and specificity of NAAT are better than the other tests available for the diagnosis of chlamydial and gonococcal infections [316, 317]. The performance of first-catch urine is non-inferior to urethral swabs [316]. In case of delayed treatment, if a NAAT is positive for gonorrhoea, a urethral swab culture should be performed

prior to treatment to assess the antimicrobial resistance profile of the infecting strain [306]. *N. gonorrhoeae* and *C. trachomatis* cultures are mainly used to assess treatment failures and to monitor the development of resistance to current treatment. Trichomonas spp. can usually be identified microscopically [306] or by NAATs [318].

Non-gonococcal urethritis is considered persistent if symptoms do not resolve within three to four weeks following treatment. In this case, NAAT for urethritis pathogens including *T. vaginalis* should be performed four weeks after completion of therapy [305, 319].

3.10.5 ***Disease management***

In the context of increasing antimicrobial resistance among potentially relevant pathogens, the question is increasingly being raised of whether empirical antibiotic therapy for urethritis, initiated before pathogen identification, remains appropriate. However, current international guidelines and reviews on urethritis in males generally recommend immediate empirical antibiotic therapy based on distinct objective findings (e.g. purulent discharge), severe patient distress, clear sexual exposure, or a high risk of transmission combined with limited follow-up availability. Conversely, empirical treatment should be deferred in favour of a diagnostic-first approach in cases of chronic symptoms, low subjective distress, lack of objective signs, or recent antibiotic pre-treatment. All sexual partners at risk should be assessed and treated whilst maintaining patient confidentiality [305, 320].

3.10.5.a Suspected gonococcal urethritis

If GU is suspected, a combination treatment using two antimicrobials is recommended [306]. Ceftriaxone 1-2g intramuscularly or intravenously with doxycycline 100mg orally twice a day for seven days should be used as first-line treatment. In cases of suspected GU with contraindications to doxycycline, and if follow-up cannot be ensured, an alternative approach is a combined empirical treatment with ceftriaxone as outlined above and azithromycin administered orally according to a four-day regimen (day 1: 1g; days 2-4: 500mg orally).

3.10.5.b Suspected non-gonococcal urethritis

For NGU without an identified pathogen, oral doxycycline 100 mg twice daily for seven days should be used as first-line treatment. In cases of suspected NGU with contraindications to doxycycline, and if follow-up cannot be ensured, an alternative empirical treatment with oral azithromycin following the four-day regimen (day 1: 1g; days 2-4: 500mg orally) should be considered.

3.10.5.c Gonococcal urethritis

In cases in which *N. gonorrhoeae* is detected, first-line therapy should consist of a single dose of ceftriaxone 1-2g given intravenously or intramuscularly. In cases of contraindications to cephalosporins and detection of *N. gonorrhoeae* with culture-confirmed sensitivity to azithromycin, treatment with oral azithromycin should be administered as follows: if coinfection with *M. genitalium* has been excluded: a single dose of 1g; if coinfection with *M. genitalium* cannot be excluded: four-day regimen (day 1: 1g; days 2-4: 500mg daily). In cases of contraindications to cephalosporins and detection of *N. gonorrhoeae* with molecularly or culture-confirmed sensitivity to ciprofloxacin, a single oral dose of ciprofloxacin 500mg may be considered. Other alternative regimens for the treatment of GU have been studied and are shown in Table 8 [306, 321-328].

3.10.5.d Non-gonococcal urethritis

3.10.5.d.1 ***Chlamydia trachomatis***

When *C. trachomatis* is detected, first-line therapy should consist of doxycycline 100mg, administered orally twice daily for seven days. If *C. trachomatis* is detected and doxycycline is contraindicated, treatment with oral azithromycin should be considered. If coinfection with *M. genitalium* has been excluded, a single dose of 1g is recommended. If coinfection with *M. genitalium* cannot be ruled out, azithromycin should be administered according to the four-day regimen, with 1g on the first day followed by 500mg daily on days two through four. Fluoroquinolones, such as ofloxacin or levofloxacin, may be used as second-line treatment only in selected cases where other agents cannot be used [329].

3.10.5.d.2 ***Mycoplasma genitalium***

In cases of *M. genitalium* detection without molecular resistance testing or without the detection of macrolide resistance-associated mutations (MRAM), first-line therapy should consist of azithromycin administered according to the four-day regimen: 1g on day one, followed by 500mg daily on days two through four. In cases of *M. genitalium* detection, treatment with moxifloxacin 400mg, taken orally once daily for seven days, is recommended if contraindications to azithromycin are present; if molecular genetic testing confirms the presence of macrolide resistance-associated mutations (MRAM); if the transmission setting suggests a high likelihood of azithromycin resistance; or if there was no response to prior treatment with azithromycin [305, 306,

330]. In case of a failure to, or contraindications to, azithromycin and moxifloxacin, treatment with sitafloxacin 100mg, taken orally twice daily for seven days, may be considered if *M. genitalium* is detected.

3.10.5.d.3 ***Mycoplasma hominis and Ureaplasma spp.***

In cases of urethral detection of *U. urealyticum*, it is often a colonisation without clinical relevance. The indication for treatment should be evaluated on an individual basis in the absence of other pathogens. Urethral detection of *M. hominis* and *U. parvum* generally indicates colonisation without clinical relevance and does not warrant treatment. If *U. urealyticum* is identified as the sole causative agent of symptomatic urethritis, treatment with doxycycline 100mg, administered orally twice daily for seven days, is recommended. If *U. urealyticum* is identified as the sole cause of symptomatic urethritis and contraindications to doxycycline are present, treatment with a single oral dose of azithromycin 1g is recommended [305, 331].

3.10.5.d.4 ***Trichomonas vaginalis***

If *T. vaginalis* is detected, first-line therapy should consist of a single oral dose of metronidazole 1.5-2g. In cases in which contraindications to metronidazole exist, an alternative treatment with tinidazole 2g orally may be considered. For treatment options for persistent or recurrent *T. vaginalis* infection, refer to the review of Sena *et al.* [318].

3.10.6 ***Follow-up***

Individuals with a clinical diagnosis of acute urethritis should be advised to abstain from sexual activity for at least one week after completion of antibiotic therapy, or longer if symptoms persist. Sexual partners from the weeks prior to the onset of symptoms should be informed of the diagnosis and the need for appropriate testing and, if necessary, treatment. If symptoms persist for more than two weeks after completion of antibiotic therapy, or if symptoms recur, follow-up medical consultation is recommended. For the initial diagnosis of *N. gonorrhoeae*, *C. trachomatis* or *M. genitalium*, a follow-up cure test should be scheduled six to twelve weeks after completion of antibiotic therapy. In addition, when urethritis is diagnosed, testing for HIV and other sexually transmitted infections should be offered in addition to the urethritis diagnostic procedures recommended in this Guideline [332].

3.10.7 ***Summary of evidence and recommendations for the diagnostic evaluation and antimicrobial treatment of urethritis***

Summary of evidence	**LE**
A Gram stain of urethral discharge or a urethral smear that shows ≥ 5 leukocytes per high-power field (× 1,000) and gonococci located intracellularly as Gram-negative diplococci indicates gonococcal urethritis.	3b
Validated NAATs of first-void urine samples have better sensitivity and specificity than any of the other tests available for the diagnosis of chlamydial and gonococcal infections.	2a
For GU dual treatment with ceftriaxone and azithromycin is the most effective combination.	2a
In case of urogenital *C. trachomatis* infection in men, azithromycin is likely less effective than doxycycline for microbiological failure.	1a
In case of *U. urealyticum* infection, the efficacy of doxycycline 100mg twice for seven days is similar to azithromycin 1g single-dose treatment.	2a

Recommendations	**Strength rating**
Perform a Gram stain of urethral discharge or a urethral smear to preliminarily diagnose gonococcal urethritis.	Strong
Perform a validated nucleic acid amplification test (NAAT) on a first-void urine sample or urethral smear prior to empirical treatment to diagnose chlamydial and gonococcal infections.	Strong
If possible, delay treatment until the results of the NAATs are available to guide treatment choice in patients with mild symptoms.	Strong
Perform a urethral swab culture, prior to initiation of treatment, in patients with a positive NAAT for gonorrhoea to assess the antimicrobial resistance profile of the infective strain.	Strong
Use a pathogen directed treatment based on local resistance data.	Strong
Sexual partners should be treated whilst maintaining patient confidentiality.	Strong

Table 9: Suggested regimens for antimicrobial therapy for urethritis

Suspected	Antimicrobial	Dosage & Duration of therapy	Alternative regimens
Gonococcal infection	Ceftriaxone Doxycycline	1-2g IM or IV*, SD 100mg b.i.d, p.o 7 days	In case of doxycycline allergy, in combination with ceftriaxone: Azithromycin four-day regimen: Day 1: 1g; Days 2-4: 500mg p.o
Non-Gonococcal infection	Doxycycline	100mg b.i.d, p.o 7 days	Azithromycin four-day regimen: Day 1: 1g; Days 2-4: 500mg p.o

** Despite the lack of RCTs, there is increasing evidence that intravenous treatment with ceftriaxone is safe and effective for the treatment of gonorrhoeal infections and avoids the discomfort of an intramuscular injection for patients [333].*

Table 10: Regimens for antimicrobial therapy for urethritis with causing pathogen detected

Pathogen	Antimicrobial	Dosage & Duration of therapy	Alternative regimens
Neisseria gonorrhoeae	Ceftriaxone Doxycycline	1-2g IM or IV*, SD 100mg b.i.d, p.o 7 days	• Azithromycin 1 g p.o, SD, if *M. genitalium* has been excluded • Azithromycin four-day regimen: Day 1: 1g; Days 2-4: 500mg p.o if *M. genitalium* cannot be ruled out • Cefixime 400mg p.o, SD plus Azithromycin 1g p.o, SD • Gentamicin 240mg i.m, SD plus Azithromycin 2g p.o, SD • Gemifloxacin 320mg p.o, SD plus Azithromycin 2g p.o, SD • Spectinomycin 2g i.m, SD • Fosfomycin trometamol 3g p.o. on days 1, 3 and 5 In case of doxycycline allergy, in combination with ceftriaxone: Azithromycin four-day regimen: Day 1 1g; Days 2-4: 500mg p.o
Chlamydia trachomatis	Doxycycline	100mg b.i.d, p.o for 7 days	• Azithromycin 1g p.o, SD, if *M. genitalium* has been excluded • Azithromycin four-day regimen: Day 1: 1g; Days 2-4: 500mg p.o if *M. genitalium* cannot be ruled out • Levofloxacin 500mg p.o, q.d 7 days • Ofloxacin 200mg p.o, b.i.d 7 days
Mycoplasma genitalium	Azithromycin	Four-day regimen: Day 1 1g; Days 2-4: 500mg p.o	In case of macrolide resistance: • Moxifloxacin 400mg q.d, p.o 7 days
Ureaplasma urealyticum	Doxycycline	100mg b.i.d, p.o 7 days	Azithromycin 1g p.o, SD
Trichomonas vaginalis	Metronidazole	1.5-2 g p.o, SD	Tinidazole 2g p.o, SD

SD = single dose; b.i.d = twice daily; q.d = every day; p.o = orally; IM = intramuscular; IV = intravenously.
** Despite the lack of RCTs, there is increasing evidence that intravenous treatment with ceftriaxone is safe and effective for the treatment of gonorrhoeal infections and avoids the discomfort of an intramuscular injection for patients [333].*

3.11 Bacterial Prostatitis

*3.11.1 **Introduction***

Bacterial prostatitis is a clinical condition caused by bacterial pathogens. Urologists are recommended to use the classification suggested by the National Institute of Diabetes, Digestive and Kidney Diseases (NIDDK) of the U.K. National Institutes of Health (NIH), in which bacterial prostatitis, with confirmed or suspected infection, is distinguished from chronic pelvic pain syndrome (CPPS) (Table 9) [334-336].

Table 9: Classification of prostatitis and CPPS according to NIDDK/NIH [334-336]

Type	Name and description
I	Acute bacterial prostatitis (ABP)
II	Chronic bacterial prostatitis (CBP)
III	Chronic non-bacterial prostatitis - CPPS
IIIA	Inflammatory CPPS (white cells in semen/EPS/VB3)
IIIB	Non-inflammatory CPPS (no white cells in semen/EPS/VB3)
IV	Asymptomatic inflammatory prostatitis (histological prostatitis)

CPPS = chronic pelvic pain syndrome; EPS = expressed prostatic secretion; VB3 = voided bladder urine specimen 3 (urine following prostatic massage).

*3.11.2 **Evidence Summary***

A systematic literature search from 1980 through June 2017 was carried out. One systematic review [337], six RCTs [338-343], two narrative reviews [344, 345], one prospective cohort study [346], two prospective cross-sectional studies [347, 348] and one retrospective cohort study [340] were selected from among 856 references.

A retrospective study [349] investigated the potential role of unusual pathogens in prostatitis syndrome in 1,442 patients over a four-year period. An infectious aetiology was determined in 74.2% of patients; *C. trachomatis*, *T. vaginalis* and *U. urealyticum* infections were found in 37.2%, 10.5% and 5% of patients, respectively; whilst *E. coli* infection was found in only 6.6% of cases. Cross sectional studies confirmed the validity of the Meares and Stamey test to determine the bacterial strain and targeted antibiotic therapies [347, 348]. The evidence levels were good, in particular those relating to information on atypical strains, epidemiology and antibiotic treatments.

A systematic review on antimicrobial therapy for CBP [337] compared multiple antibiotic regimens from eighteen selected studies enrolling a total of 2,196 patients. The role of fluoroquinolones as first-line agents was confirmed with no significant differences between levofloxacin, ciprofloxacin and prulifloxacin in terms of microbiological eradication, clinical efficacy and adverse events. The efficacy of macrolides and tetracyclines on atypical pathogens was confirmed.

Randomised controlled trials on combined treatments [342, 343] indicated that the combination of plants/herbal extracts or PDE5Is with antibiotics may improve quality of life and symptoms in patients with CBP. However, the number of enrolled patients was inadequate to obtain definitive conclusions.

A review of treatment of bacterial prostatitis [344] indicated that the treatment of CBP is hampered by the lack of an active antibiotic transport mechanism into infected prostate tissue and fluids. The review underlined the potential effect of various compounds in the treatment of ABP and CBP on the basis of over 40 studies on the topic.

One RCT compared the effects of two different metronidazole regimens for the treatment of CBP caused by *T. vaginalis* [341]. Metronidazole 500mg three times daily for 14 days was found to be efficient for pathogen eradication in 93.3% of patients with clinical failure in 3.33% of cases.

*3.11.3 **Epidemiology, aetiology and pathogenesis***

Prostatitis is a common diagnosis, but fewer than 10% of cases have proven bacterial infection [228]. *Enterobacterales*, particularly *E. coli*, are the predominant pathogens in ABP [350]. In CBP, the spectrum of species is wider and may include atypical microorganisms [344]. In patients with immune deficiency or HIV infection, prostatitis may be caused by fastidious pathogens, such as *M. tuberculosis*, *Candida spp.*, and other rare pathogens, such as *Coccidioides immitis*, *Blastomyces dermatitidis*, and *Histoplasma capsulatum* [351]. The significance of identified intracellular bacteria, such as *C. trachomatis*, is uncertain [352]. However, two studies have highlighted its possible role as a pathogen in CBP [353, 354].

*3.11.4 **Diagnostic evaluation***

3.11.4.a History and symptoms

Acute bacterial prostatitis usually presents abruptly with voiding symptoms and distressing but poorly localised pain, and is often associated with malaise and fever. Transrectal prostate biopsy increases the risk of ABP despite antibiotic prophylaxis and antiseptic prevention procedures [338]. Chronic bacterial prostatitis is defined by symptoms that persist for at least three months [355-357]. The predominant symptoms are pain at various locations, including the perineum, scrotum, penis and inner part of the leg, as well as LUTS [334-336].

3.11.4.b Symptom questionnaires

In CBP, symptoms appear to have a strong basis for use as a classification parameter [358]. Prostatitis symptom questionnaires have therefore been developed to assess severity and response to therapy [358, 359]. These questionnaires include the validated Chronic Prostatitis Symptom Index (CPSI), however, the usefulness of the CPSI in clinical practice is uncertain [346].

3.11.4.c Clinical findings

In ABP, the prostate may be swollen and tender on DRE. Prostatic massage should be avoided, as it can induce bacteraemia and sepsis. Urine dipstick testing for nitrite and leukocytes has a positive predictive value of 95% and a negative predictive value of 70% [360]. Blood culture and complete blood count are useful in ABP. Imaging studies can detect a suspected prostatic abscess [344].

In case of longer-lasting symptoms, CPPS as well as other urogenital and anorectal disorders must be taken into consideration. Symptoms of CBP or CPPS can mask prostate tuberculosis. Pyospermia and hematospermia in males in endemic regions or with a history of tuberculosis should trigger investigation for urogenital tuberculosis.

3.11.4.d Urine cultures and expressed prostatic secretion

The most important investigation in the evaluation of a patient with ABP is midstream urine culture [344]. In CBP, quantitative bacteriological localisation cultures and microscopy of the segmented urine and expressed prostatic secretion (EPS), as described by Meares and Stamey [361], are still important investigations to categorise clinical prostatitis [347, 348]. Accurate microbiological analysis of samples from the Meares and Stamey test may also provide useful information on the presence of atypical pathogens such as *C. trachomatis*, *T. vaginalis* and *U. urealiticum* [349]. The two-glass test has been shown to offer similar diagnostic sensitivity to the four-glass test [362].

3.11.4.e Prostate biopsy

Prostate biopsies cannot be recommended as routine workup and are not advisable in patients with untreated bacterial prostatitis, due to the increased risk of sepsis.

3.11.4.f Other tests

Transrectal ultrasound may reveal endoprostatic abscesses, calcification in the prostate and dilatation of the seminal vesicles. However, ultrasound is unreliable as a diagnostic tool for prostatitis [363].

3.11.4.g Additional investigations

3.11.4.g.1 Ejaculate analysis

Performing an ejaculated semen culture improves the diagnostic utility of the four-glass test [347], however, semen cultures are more often positive than EPS cultures in males with non-bacterial prostatitis [348]. Bladder outflow and urethral obstruction should always be considered and ruled out by uroflowmetry, retrograde urethrography or endoscopy.

3.11.4.g.2 First-void urine sample

First-void urine is the preferred specimen for the diagnosis of urogenital *C. trachomatis* infection in men by NAATs, because it is non-invasive and yet allows the detection of infected epithelial cells and associated *C. trachomatis* particles [364].

3.11.4.g.3 Prostate-specific antigen (PSA)

Prostate-specific antigen (PSA) level is increased in approximately 60% and 20% of males with ABP and CBP, respectively [345]. The PSA level decreases after antibiotic therapy (which occurs in approximately 40% of patients) and correlates with clinical and microbiological improvement [339]. Measurement of free and total PSA adds no practical diagnostic information in prostatitis [365].

3.11.4.h Summary of evidence and recommendations for the diagnosis of bacterial prostatitis

Summary of evidence	LE
Urine dipstick testing for nitrite and leukocytes has a positive predictive value of 95% and a negative predictive value of 70% in patients with ABP.	3
The four-glass Meares and Stamey test is the optimum test for diagnosis of CBP. The two-glass test has been shown to offer similar diagnostic sensitivity in a comparison study.	2b
First-void urine is the preferred specimen for the diagnosis of urogenital *C. trachomatis* infection in men by NAATs.	2b
Transrectal ultrasound is unreliable and cannot be used as a diagnostic tool in prostatitis.	3
Semen culture sensitivity is reported to be approximately 50% and is, therefore, not routinely part of the diagnostic assessment of CBP.	3
Prostate-specific antigen levels may be elevated during active prostatitis. Therefore, PSA testing should be avoided, as it offers no practical diagnostic information for prostatitis.	3

Recommendations	Strength rating
Do not perform prostatic massage in acute bacterial prostatitis (ABP).	Strong
Take a midstream urine dipstick to check nitrite and leukocytes in patients with clinical suspicion of ABP.	Weak
Take a midstream urine culture in patients with ABP symptoms to guide diagnosis and tailor antibiotic treatment.	Weak
Take a blood culture and a total blood count in patients presenting with ABP.	Weak
Perform accurate microbiological evaluation for atypical pathogens such as *Chlamydia trachomatis* or *Mycoplasma* spp. in patients with chronic bacterial prostatitis (CBP).	Weak
Perform the Meares and Stamey 2- or 4-glass test in patients with CBP.	Strong
Perform transrectal ultrasound in selected cases to rule out the presence of prostatic abscess.	Weak
Do not routinely perform microbiological analysis of the ejaculate alone to diagnose CBP.	Weak

*3.11.5 **Disease management***

3.11.5.a Antimicrobials

Antimicrobials are life-saving in ABP and recommended in CBP. Culture-guided antibiotic treatments are the optimum standard, however, empirical therapies should be considered in all patients with ABP.

In ABP, parenteral administration of high doses of bactericidal antimicrobials, such as broad-spectrum penicillins, a third-generation cephalosporin or fluoroquinolones, is recommended [366]. For initial therapy, any of these antimicrobials can be combined with an aminoglycoside [350-359, 366-370]. Ancillary measures include adequate fluid intake and urine drainage [228]. After normalisation of infection parameters, oral therapy can be substituted and continued for a total of two to four weeks [371].

Fluoroquinolones, despite the high resistance rates of uropathogens, are recommended as first-line agents in the empirical treatment of CBP, due to their favourable pharmacokinetic properties [372], their generally good safety profile, and antibacterial activity against Gram-negative pathogens, including *P. aeruginosa* and *C. trachomatis* [337, 373]. However, increasing bacterial resistance is a concern. Azithromycin and doxycycline are active against atypical pathogens such as *C. trachomatis* and genital *Mycoplasma spp.* [340, 349]. Levofloxacin did not demonstrate significant clearance of *C. trachomatis* in patients with CBP [374]. Metronidazole treatment is indicated in patients with *T. vaginalis* infections [341].

Duration of fluoroquinolone treatment must be at least fourteen days, while azithromycin and doxycycline treatments should be extended to at least three to four weeks [340, 349]. In CBP, antimicrobials should be given for four to six weeks after initial diagnosis [344]. If intracellular bacteria have been detected, macrolides or tetracyclines should be given [337, 372, 375].

3.11.5.b Intraprostatic injection of antimicrobials

This treatment has not been evaluated in controlled trials and should not be considered [376, 377].

3.11.5.c Combined treatments

A combination of fluoroquinolones with various herbal extracts may attenuate clinical symptoms without increasing the rate of adverse events [342]. However, a combination of fluoroquinolones with vardenafil did not improve microbiological eradication rates or attenuated pain or voiding symptoms in comparison with fluoroquinolone treatment alone [343].

3.11.5.d Drainage and surgery

Approximately 10% of males with ABP will experience urinary retention [378] that can be managed by urethral or suprapubic catheterisation. However, recent evidence suggests that suprapubic catheterisation can reduce the risk of development of CBP [379].

In case of prostatic abscess, both drainage and conservative treatment strategies appear feasible [380], however, the abscess size may matter. In one study, conservative treatment was successful if the abscess cavities were < 1cm in diameter, while larger abscesses were better treated by single aspiration or continuous drainage [381].

3.11.5.e Summary of evidence and recommendations for the disease management of bacterial prostatitis

Summary of evidence	LE
The treatment regimen for ABP is based on clinical experience and a number of uncontrolled clinical studies. For systemically ill patients with ABP, parenteral antibiotic therapy is preferable. After normalisation of infection parameters, oral therapy can be substituted and continued for a total of two to four weeks.	3
The role of fluoroquinolones as first-line agents for antimicrobial therapy for CBP was con-firmed in a systematic review, with no significant differences between levofloxacin, ciprofloxacin and prulifloxacin in terms of microbiological eradication, clinical efficacy and adverse events.	1a
Metronidazole 500mg three times daily for fourteen days was found to be efficient for eradication in 93.3% of patients with *T. vaginalis* CBP.	1b
In patients with CBP caused by obligate intracellular pathogens, macrolides showed higher microbiological and clinical cure rates compared to fluoroquinolones.	1a
Clinicians should consider local drug-resistance patterns when choosing antibiotics.	3

Recommendations	Strength rating
Acute bacterial prostatitis (ABP)	
Treat ABP according to the recommendations for systemic UTIs (see Section 3.7.4).	Strong
Chronic bacterial prostatitis (CBP)	
Prescribe a fluoroquinolone (e.g. ciprofloxacin, levofloxacin) as first-line treatment for CBP.	Strong
Prescribe a macrolide (e.g. azithromycin) or a tetracycline (e.g. doxycycline) if intracellular bacteria have been identified as the causative agent of CBP.	Strong
Prescribe metronidazole in patients with *T. vaginalis* CBP.	Strong

Table 10: Suggested regimens for antimicrobial therapy for chronic bacterial prostatitis

Antimicrobial	Daily dose	Duration of therapy	Comments
Fluoroquinolone	Optimal oral daily dose	4-6 weeks	
Doxycycline	100mg b.i.d	10 days	Only for *C. trachomatis* or mycoplasma infections
Azithromycin	500mg o.d	up to 3 weeks	Only for *C. trachomatis* infections
Metronidazole	500mg t.i.d	14 days	Only for *T. vaginalis* infections

b.i.d = twice daily; o.d = once daily; t.i.d = three times daily.

*3.11.6 **Follow-up***

In asymptomatic post-treatment patients, routine urinalysis and/or urine culture is not mandatory as there are no validated tests of cure for bacterial prostatitis except for cessation of symptoms [344]. In patients with persistent symptoms and repeated positive microbiological results for sexually transmitted infectious pathogens, microbiological screening of the patient's partner/s is recommended. Antibiotic treatments may be repeated with a more prolonged course, higher dosage and/or different compounds [344].

3.12 Acute epididymitis

*3.12.1 **Epidemiology, aetiology and pathophysiology***

Epididymitis is a common condition with incidence ranging from 25 to 65 cases per 10,000 adult males per year and can be acute, chronic or recurrent [382]. Acute epididymitis is clinically characterised by unilateral pain, palpable swelling and increased temperature of the epididymis, which worsen over several days. The testes and scrotal skin may be involved. The pain is typically localised to the posterior aspect of the testis affected. Acute epididymitis is generally caused by sexually transmitted infections (STIs) or *Enterobacterales*. Pathogens migrate from the urethra or bladder and can be identified by appropriate diagnostics in up to 90% of patients [383].

The predominant pathogens isolated in sexually transmitted epididymitis in otherwise healthy young and sexually active biological men are *N. gonorrhoeae*, *C. trachomatis*, *U. urealyticum* and *M. genitalium*. Acute epididymitis caused by an STI is usually accompanied by urethritis and discharge, which in case of gonorrhoea is thick, green, white or yellow and very productive. Non-sexually transmitted epididymitis is typically caused by *Enterobacterales* (e.g. *E. coli*) [384]. Older patients with a history of urinary tract infection are most commonly affected. Risk factors include benign prostatic hyperplasia, neurogenic bladder and recent instrumentation. Males who have unprotected anal intercourse are at higher risk of epididymitis caused by *Enterobacterales* [385]. The mumps virus should be considered in case of bilateral scrotal involvement, viral prodromal symptoms and salivary gland enlargement. Tuberculous epididymitis may occur, typically as chronic epididymitis, in high-risk groups such as males with immunodeficiency and those from countries with a high prevalence of tuberculous. Tuberculous epididymitis frequently results in a discharging scrotal sinus. *Brucella* or *Candida spp.* are rare potential pathogens. Torsion of the spermatic cord (testicular torsion) is the most important differential diagnosis in boys and young males.

*3.12.2 **Diagnostic Evaluation***

Culture of a midstream specimen of urine should be performed, and any previous urine culture results should be checked. Sexually transmitted infections including *C. trachomatis* or *N. gonorrhoeae* should be detected by means of NAAT on first-voided urine or urethral swab. A urethral swab or smear might be performed for Gram staining and culture of *N. gonorrhoeae*, when available [382, 386, 387]. Detection of these pathogens should be reported according to local procedures. All patients with probable STIs should be screened for other STIs. Patients with *Enterobacterales* may require investigation for lower urinary tract abnormalities. If tuberculous epididymitis is suspected, three sequential early morning urine samples should be cultured for acid-fast bacilli (AFB) and sent for screening by NAAT for *M. tuberculosis* DNA [388]. If appropriate, prostate secretion, ejaculate, discharge from a draining scrotal fistula as well as fine-needle aspiration and biopsy specimens should be investigated using microscopy, AFB culture and NAAT. Scrotal ultrasound is more accurate for the diagnose of acute epididymitis than urinalysis alone [389] and may also be beneficial for the exclusion of other pathologies [390].

*3.12.3 **Disease Management***

Empirical antimicrobial therapy must be chosen with consideration of the most probable pathogen and degree of penetration into the inflamed epididymis and may need to be varied according to local pathogen sensitivities and guidance. Generally, both *C. trachomatis* and *Enterobacterales* should be covered initially and the regimen modified according to pathogen identification. Doxycycline and fluoroquinolones have good clinical and microbiological cure rates in patients with suspected *C. trachomatis* or *M. genitalium*, and both achieve adequate levels in inflamed male genital tissues with oral dosing. Macrolide antibiotics such as azithromycin are effective against *C. trachomatis* but have not been tested in epididymitis. However, initial pharmacokinetic studies suggest that azithromycin may effectively penetrate epididymal tissue when given in multiple doses [391]. Fluoroquinolones remain effective for oral treatment of *Enterobacterales*, although resistance is increasing and local advice should be sought. Fluoroquinolones should not be considered for gonorrhoea. Single parenteral dose of ceftriaxone is effective against *N. gonorrhoeae*. However, current resistance patterns and local public health recommendations should guide choice of agent. Patients with likely or proven STI should be assessed fourteen days after end of treatment to ensure that the patient has been cured and ensure tracing and treatment of contacts according to local public health recommendations. Nonsteroidal anti-inflammatory

drugs and local cooling can be used to manage pain and swelling. Elevating the scrotum may also help reduce discomfort. Men with suspected STI should be informed of the risks to others and advised not to have sex until they are free of infection. In exceptional cases, individuals with epididymitis may experience severe pain, fever, a testicular abscess or signs of systemic illness. These patients should be admitted to the hospital for intravenous antibiotic treatment and fluid replacement.

*3.12.4 **Evidence Summary***

Relating to this chapter, four guidelines based on systematic reviews were identified [306, 386, 392, 393]. No evidence quality assessments were detailed. A high-quality RCT demonstrated that a ten-day course of ciprofloxacin was superior to pivampicillin for clinical cure (80% vs. 60%) in men aged > 40 years [394]. Data from a large comparative case series suggested that young age and history of sexual activity are not sufficiently predictive of a sexually transmitted pathogen to guide antibiotic treatment in acute epididymitis [383].

Empiric antibiotic regimens from existing guidelines [306, 386, 392, 393] and panel consensus:

1. For males with acute epididymitis at low risk of gonorrhoea (e.g. no urethritis, no urethral discharge), a single agent active against *Enterobacterales* and *C. trachomatis* (e.g. levofloxacin) or a combination of two agents (e.g. doxycycline and trimethoprim-sulfamethoxazol) to eradicate *C. trachomatis* and *Enterobacterales* should be used. Options include:

    A. Levofloxacin 500mg orally once daily for ten to fourteen days*

    OR

    B. Doxycycline 200mg orally initial dose and then 100mg twice daily for ten to fourteen days* **plus** trimethoprim-sulfamethoxazol 160/800mg twice daily for ten to fourteen days**

2. For biological males with likely gonorrhoeal acute epididymitis, a combination regimen active against *N. gonorrhoeae* and *C. trachomatis* must be used, such as:

    A. Ceftriaxone 1,000mg intramuscularly or i.v. single dose **plus** doxycycline 200mg orally initial dose and then 100mg twice daily for ten to fourteen days*

3. For non-sexually active males with acute epididymitis, a single agent of sufficient dose and duration to eradicate *Enterobacterales* should be used. Appropriate option is a fluoroquinolone once daily (e.g. levofloxacin 500mg) or trimethoprim-sulfamethoxazol 160/800mg orally twice daily for ten to fourteen days*.

**Depending upon pathogen identification and clinical response.*
***A parenteral option will be required for men with severe infection requiring hospitalisation.*

Surgical exploration may be required to drain abscesses or debride tissue. A comparative cohort study found that lack of separation of epididymis and testis on palpation and the presence of abscess on ultrasound may predict requirement for surgery following initial antibiotic treatment [395].

A cohort study found that semen parameters may be impaired during epididymitis but recovered following successful treatment [396]. Comparative clinical cohort studies suggest that adherence to guidelines for assessment and treatment of epididymitis is low, particularly by urologists compared to sexual health specialists [397] and by primary care physicians [398].

*3.12.5 **Screening***

A large cohort screening study for carriage of *C. trachomatis* including a randomly selected group of 5,000 males of whom 1,033 were tested, showed no benefit in terms of reduction in risk of epididymitis over nine years of observation [399].

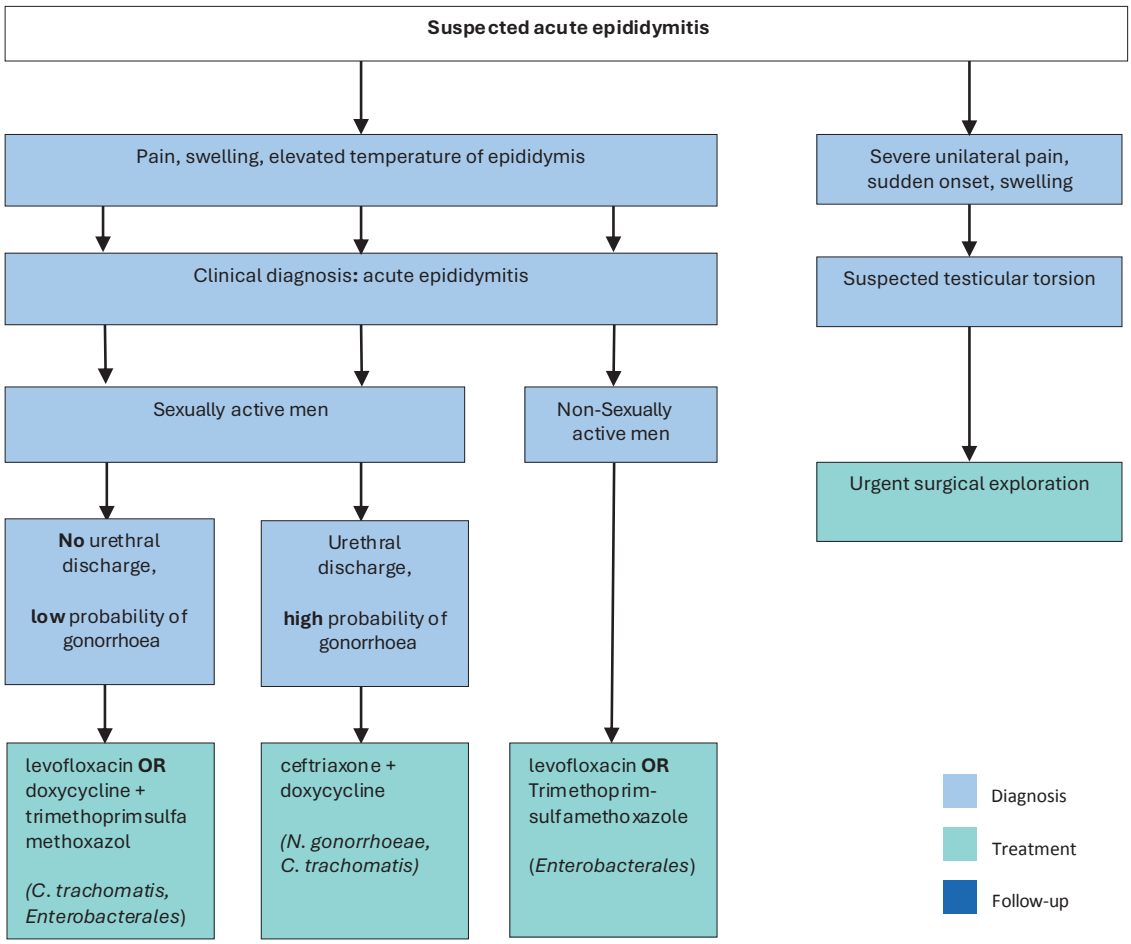
3.12.6 *Summary of evidence and recommendations for the diagnosis and treatment of acute infective epididymitis*

Summary of evidence	LE
In young, sexually active patients, both STIs and *Enterobacterales* must be considered as aetiological agents.	3
In patients > 40 years, antibiotic therapy with ciprofloxacin is superior to pivmecillinam.	1b
A negative sexual risk history does not exclude STIs in sexually active men.	3

Recommendations	Strength rating
Obtain a mid-stream urine and a first-voided urine for pathogen identification by culture and nucleic acid amplification test.	Strong
Initially prescribe a single antibiotic or a combination of two antibiotics active against *Chlamydia trachomatis* and *Enterobacterales* in young, sexually active men. In older men without sexual risk factors, only *Enterobacterales* have to be considered.	Strong
If gonorrhoeal infection is likely, give single-dose ceftriaxone 1,000mg intramuscularly or intravenously* in addition to a course of an antibiotic active against *Chlamydia trachomatis*.	Strong
Adjust antibiotic agent when pathogen has been identified and adjust duration according to clinical response.	Weak
Follow national policies on reporting and tracing/treatment of contacts for sexually transmitted infections.	Strong

** Despite the lack of RCTs there is increasing evidence that intravenous treatment with ceftriaxone is safe and effective for the treatment of gonorrhoeal infections and avoids the discomfort of an intramuscular injection for patients [333].*

Figure 2: Diagnostic and treatment algorithm for men with acute epididymitis



i.m. = intramuscular; i.v. = intravenously.
** Despite the lack of RCTs there is increasing evidence that intravenous treatment with ceftriaxone is safe and effective for the treatment of gonorrhoeal infections and avoids the discomfort of an intramuscular injection for patients [333].*

3.13 Fournier's gangrene (necrotising fasciitis of the perineum and external genitalia)

3.13.1 Epidemiology, aetiology and pathophysiology

Fournier's gangrene is an aggressive and frequently fatal polymicrobial soft tissue infection of the perineum, perianal region and external genitalia [400]. It is an anatomical subcategory of necrotising fasciitis with which it shares a common aetiology and management pathway.

3.13.2 Diagnostic Evaluation

Fournier's gangrene is typically accompanied by painful swelling of the scrotum or perineum and characterised by severe inflammation and infection spreading along fascial planes, often leading to rapid tissue destruction and sepsis [400]. Examination shows small necrotic areas of skin with surrounding erythema and oedema. Crepitus on palpation and a foul-smelling exudate occurs with more advanced disease. Patient risk factors for occurrence and mortality include being immunocompromised - most commonly diabetes or malnutrition - as well as recent urethral or perineal surgery and high body mass index (BMI). In up to 40% of cases, the onset is more insidious, with undiagnosed pain often resulting in delayed treatment [401]. A high index of suspicion and careful examination, particularly of obese patients, is required. Computed tomography or MRI can help define pararectal involvement, suggesting the need for bowel diversion [400].

3.13.3 Disease Management

The degree of internal necrosis is usually vastly greater than suggested by external signs, and consequently, adequate, repeated surgical debridement with urinary diversion by suprapubic catheter is required to reduce mortality [400]. Consensus from case series suggests that surgical debridement should be early (< 24 hours) and complete, as delayed and/or inadequate surgery may result in higher mortality [400]. Immediate empiric parenteral antibiotic treatment should be given that covers all probable causative organisms and can penetrate inflammatory tissue. A suggested regimen would comprise a broad-spectrum penicillin or third-generation cephalosporin, gentamicin and metronidazole or clindamycin [400]. This can then be refined, guided by microbiological culture.

3.13.4 Evidence summary

A systematic literature search from 1980 to July 2017 was performed. From among 640 references, one RCT [402], two systematic reviews [403, 404], one narrative review [400], three registry studies [405-407], one prospective cohort study [408] and two retrospective comparative cohort studies with at least 25 patients [409, 410] were selected. The three registry studies from the United States [405-407] found mortality rates of 10%, 7.5% and 5% from 650, 1,641 and 9,249 cases, respectively. Older age, diabetes and high BMI were associated with higher risk. A prospective cohort study showed that disease-specific severity scores did predict outcome but were not superior to generic scoring systems for critical care [408]. The evidence questions addressed were:

1. What is the best antimicrobial treatment strategy to reduce mortality?
2. What is the best debridement and reconstruction strategy to reduce mortality and aid recovery?
3. Are any effective adjuvant treatments available that improve outcome?

Concerning the evidence questions:

A. A low-quality retrospective case series [409] with 168 patients found no significant difference in mortality between patients given ≤ 10 days of parenteral antibiotics (80 patients) and those given > 10 days (88 patients).

B. A systematic review of wound closure techniques [404] found low-quality evidence from 16 case series involving 425 male patients. These case series recommended primary or secondary wound closure for scrotal defects ≤ 50%, and the use of flaps or skin grafts for defects involving > 50% of the scrotum or with extension outside the scrotum.

C. A systematic review on the use of hyperbaric oxygen therapy [403] included three comparative case series and four other case series. All were retrospective and published prior to 2000. No consistent evidence of benefit was found; an RCT was advised. A more recent comparative case series [410] suggested benefit for use of hyperbaric oxygen therapy in 16 patients compared to 12 cases without use of such therapy in terms of reduced mortality and fewer debridements (low quality evidence). A low-quality RCT [402] with 30 patients found that the use of honey-soaked dressings resulted in a shorter hospital stay

(28 vs. 32 days) than dressing soaked with Edinburgh solution of lime (EUSOL). We found no evidence of benefit for use of negative-pressure (vacuum) wound therapy in Fournier's gangrene.

3.13.5 *Summary of evidence and recommendations for the disease management of Fournier's gangrene*

Summary of evidence	LE
Immediate empiric parenteral antibiotic treatment should be given that covers all probable causative organisms and can penetrate inflammatory tissue.	3
A systematic review of wound closure techniques recommended primary or secondary wound closure for scrotal defects ≤ 50%, and the use of flaps or skin grafts for defects involving > 50% of the scrotum or with extension outside the scrotum.	3
No consistent evidence of benefit for hyperbaric oxygen therapy was found.	3
A low-quality RCT found that dressings soaked in honey resulted in a shorter hospital stay than dressings soaked in EUSOL.	3
No evidence of benefit for use of negative-pressure (vacuum) wound therapy in Fournier's gangrene was found.	4

Recommendations	Strength rating
Start treatment for Fournier's gangrene with broad-spectrum antibiotics on presentation, with subsequent refinement according to culture results and clinical response.	Strong
Commence repeated surgical debridement for Fournier's gangrene within 24 hours of presentation.	Strong
Do not use adjunctive treatments for Fournier's gangrene except in the context of clinical trials.	Weak

Table 11: Suggested regimens for antimicrobial therapy for Fournier's gangrene of mixed microbiological aetiology adapted from [411]

Antimicrobial	Dosage
Piperacillin-tazobactam plus Vancomycin	4.5g q.i.d. or t.i.d, IV 15mg/kg b.i.d
Imipenem-cilastatin	Standard dosage: 0.5g IV q.i.d over 30 minutes High dosage: 1g IV q.i.d over 30 minutes
Meropenem	1g t.i.d. IV
Ertapenem	1g o.d.
Gentamicin	6-7 mg/kg IV q.d
Cefotaxime plus metronidazole or clindamycin	2g q.i.d IV 500mg q.i.d IV 600-900mg t.i.d IV
Cefotaxime plus fosfomycin plus metronidazole	2g q.i.d IV 5g t.i.d IV 500mg q.i.d IV

b.i.d = twice daily; IV = intravenous; o.d = once daily; q.i.d = four times daily; q.d = every day; t.i.d = three times daily.

3.14 Management of human papillomavirus in men

*3.14.1 **Epidemiology***

Human papilloma virus (HPV) is one of the most frequently sexually transmitted viruses, encompassing both oncogenic (low- and high-risk variants) and non-oncogenic viruses. Urologists primarily encounter male patients presenting with visible external genital lesions, most notably condylomata acuminata, or obstructive voiding symptoms caused by meatal involvement. Additionally, consultations are frequently driven by the need for screening and counselling following a confirmed high-risk HPV diagnosis in a sexual partner. HPV16 is the most common oncogenic variant, detected in 20% of all HPV cases [412]. A recent meta-analysis revealed a prevalence of 49% of any type of HPV and 35% of high-risk HPV in males [413]. Similar to the female genital tract, half of all HPV infections in the male genital tract are co-infections (≥ 2 HPV strains) [414].

HPV presence is dependent on the clinical setting. In men attending urological clinics, HPV was detected in 6% of urine samples [415]. A meta-analysis reported seminal HPV in 4.5-15.2% of patients resulting in seminal HPV being associated with decreased male fertility [412]. A cross-sectional study of 430 males presenting for fertility treatment detected HPV in 14.9% of semen samples [416]. The presence of HPV in semen was not associated with impaired semen quality [416]. However, another systematic review reported a possible association between HPV and altered semen parameters and, in women, possible miscarriage or premature rupture of the membrane during pregnancy [417]. HPV6 and/or 11 were the most common genotypes detected in an observational study of anogenital warts, whilst HPV16 is correlated with severity of anal cytology [418]. The incidence of non-oncogenic HPV infection has been shown to be higher in males than females [419]. In males, approximately 33% of penile cancers and up to 90% of anal cancers are attributed to high-risk HPV infections, primarily with HPV16 [420]. Oral HPV is associated with oropharyngeal carcinomas. Approximately 22.4%, 4.4% and 3.5% of oral cavity, oropharynx and larynx cancers, respectively, are attributed to HPV [420]. Systematic reviews have reported prevalence rates of oral HPV from 5.5-7.7%, with HPV16 present in 1-1.4% of patients [421, 422].

*3.14.2 **Risk factors***

Risk factors for HPV infection include early age of first sexual intercourse, sexual promiscuity, higher frequency of sexual intercourse, smoking and poor immune function [423-427]. Incidence and prevalence of overall HPV was considerably higher in men who have sex with men (MSM) compared to heterosexuals [421, 424]. Overall, the prevalence of HPV in different sites appears to be higher in young, sexually active adults compared to other population groups [423]. Stable sexual habits, circumcision and condom use are protective factors against HPV [413, 427-431]. Added risk factors of oral HPV infection are alcohol consumption, poor oral hygiene and sexual behaviours (oral and vaginal) [421, 423]. Positive HIV status, phimosis, and HPV status of the partner have also been associated with anogenital HPV status and decreased clearance [428].

*3.14.3 **Transmission***

HPV typically spreads by sustained direct skin-to-skin or mucosal contact, with vaginal, oral and anal sex being the most common transmission routes [425]. In addition, HPV has been found on surfaces in medical settings and public environments, thus raising the possibility of object-to-skin/mucosa transmission [432]. Further studies on non-sexual and non-penetrative sexual transmission are needed to understand the complexity of HPV transmission. HPV transmission may also be influenced by genotype, with a higher incidence of HPV51 and HPV52 and a high prevalence of HPV16 and HPV18 in the general and high-risk male population [425].

*3.14.4 **Clearance***

HPV time-to-clearance ranges from 1.3 to 42.1 months [433]. Clearance may be influenced by HPV genotype, patients' characteristics and affected body site [424, 428, 433]. HPV16 has the highest incidence of high-risk HPV variants and has the lowest clearance across sites [428].

*3.14.5 **Diagnosis***

There is currently no approved test for HPV in males. Routine testing to check for HPV or HPV-related disease in males are not recommended. A physical examination to identify HPV lesions should be carried out. An acetic acid test to diagnose subclinical HPV lesions may be performed. If the diagnosis is uncertain or if there is a suspicion of cancer, a biopsy should be carried out. Intraurethral condylomas are relatively uncommon and are usually limited to the distal urethral meatus [434, 435]. Urethrocystoscopy may be used to diagnose the presence of intraurethral or bladder warts [435]; however, there is no high-level evidence for the use of invasive diagnostic tools for localisation of intraurethral HPV. For detailed recommendations on the diagnosis of anogenital warts, please refer to the IUSTI-European guideline for the management of anogenital warts [436].

3.14.6 Treatment of HPV-related diseases

Approximately 90% of HPV infections do not cause any problems and are cleared by the body within two years. However, treatment is required when HPV infection manifests as anogenital warts to prevent the transmission of HPV-associated anogenital infection and to minimise the discomfort caused to patients [436]. Of the treatment options available, only surgical treatment has a primary clearance rate approaching 100%.

3.14.6.a Treatments suitable for self-application

Patient-applied treatments include podophyllotoxin, salicylic acid, imiquimod, polyphenon E, 5-fluoracil and potassium hydroxide [436]. Imiquimod 5% cream showed a total clearance of external genital or perianal warts in 50% of immunocompetent patients [437] as well as in HIV positive patients successfully treated with highly active antiretroviral therapy [438]. A Cochrane review of published RCTs found imiquimod to be superior to placebo in achieving complete clearance of warts (RR: 4.03, 95% CI: 2.03-7.99) [439]. The recommended treatment schedule is imiquimod 5% cream applied to all external warts overnight three times each week for 16 weeks [436]. In an RCT involving 502 patients with genital and/or perianal warts, sinecatechins 15% and 10% showed a complete clearance of all baseline and newly occurring warts in 57.2% and 56.3% of patients, respectively, versus 33.7% for placebo [440]. In addition, sinecatechins 10% has been shown to be associated with lower short-term recurrence rates when used as sequential therapy after laser CO_2 ablative therapy [441]. Sinecatechins is applied three times daily until complete clearance, or for up to 16 weeks. Clearance rates of 36-83% for podophyllotoxin solution and 43-70% for podophyllotoxin cream have been reported [436]. A systematic review and meta-analysis confirmed the effectiveness of podophyllotoxin 0.5% solution relative to placebo (RR: 19.86, 95% CI: 3.88-101.65) [442]. Podophyllotoxin is self-applied to lesions twice daily for three days, followed by four rest days, for up to four or five weeks. An RCT has also shown potassium hydroxide 5% to be an effective, safe and low-cost treatment modality for genital warts in men [443].

3.14.6.b Physician-administered treatment

Physician-administered treatments included cryotherapy (79-88% clearance rate; 25-39% recurrence rate), surgical treatment (61-94% clearance rate), including excision, electrosurgery, electrocautery and laser therapy (75% clearance rate) [444, 445]. Physician-administered therapies are associated with close to 100% clearance rates, but they are also associated with high rates of recurrence, as they often fail to eliminate invisible HPV-infected lesions [444, 445]. No data on the superiority of one treatment over another are available. However, among all interventions evaluated in a recent systematic review and network meta-analysis, surgical excision appeared to be the most effective treatment at minimising risk of recurrence [446].

3.14.6.c Summary of evidence and recommendations for the treatment of anogenital warts

Summary of evidence	LE
A Cochrane review of published RCTs found imiquimod to be superior to placebo in achieving complete clearance of warts.	1b
In an RCT, sinecatechins 15% and 10% showed a complete clearance of all baseline and newly occurring warts in 57.2% and 56.3% of patients, respectively, versus 33.7% for placebo.	1b
A systematic review and meta-analysis confirmed the effectiveness of podophyllotoxin 0.5% solution relative to placebo.	1b
A systematic review and meta-analysis reported that among all physician-applied therapies, surgical excision seemed to be the most effective at minimising risk of recurrence.	1a

Recommendations	Strength rating
Use self-administered imiquimod 5% cream applied to all external warts overnight three times each week for 16 weeks for the treatment of anogenital warts.	Strong
Use self-administered sinecatechins 15% or 10% applied to all external warts three times daily until complete clearance, or for up to 16 weeks for the treatment of anogenital warts.	Strong
Use self-administered podophyllotoxin 0.5% self-applied to lesions twice daily for three days followed by four rest days for up to four or five weeks for the treatment of anogenital warts.	Strong
Use cryotherapy or surgical treatment (excision, electrosurgery, electrocautery and laser therapy) to treat anogenital warts based on an informed discussion with the patient.	Strong

3.14.7 Circumcision for reduction of HPV prevalence

Male circumcision is a simple surgical procedure that has been shown to reduce the incidence of STIs, including HIV, syphilis and HSV-2 [447]. Two systematic reviews and meta-analyses showed an inverse association between male circumcision and genital HPV prevalence in males [431, 433]. It has been suggested that male circumcision could be considered as an additional one-time preventative intervention likely to reduce the burden of HPV-related diseases in both males and females, particularly among those countries in which HPV vaccination programmes and cervical screening are not available [433].

Summary of evidence	LE
Two systematic reviews and meta-analyses showed an inverse association between male circumcision and genital HPV prevalence in males.	1a

Recommendation	Strength rating
Discuss male circumcision with patients as an additional one-time preventative intervention for HPV-related diseases.	Strong

3.14.8 Therapeutic vaccination

To date, three different vaccines against HPV have been licensed, but routine vaccination of males is currently implemented in only a few countries, including Australia, Canada, the United States and Austria. The aim of male vaccination is to reduce the rate of anal and penile cancers as well as head and neck cancers [420, 448].

A systematic review including a total of 5,294 patients reported vaccine efficacy against persisting (at least six months) anogenital HPV16 infections of 46.9% (28.6-60.8%) and against persisting oral infections of 88% (2-98%). A vaccine efficacy of 61.9% (21.4-82.8%) and 46.8% (20-77.9%) was observed against anal intraepithelial neoplasia grade 2 and 3 lesions, respectively [420]. The systematic review reported no meaningful estimates on vaccine efficacy against penile intraepithelial neoplasia grade 2 or 3, and no data were identified for anal, penile or head and neck squamous cell cancers [420].

A phase III clinical trial including 180 male patients evaluated the potential of MVA E2 recombinant vaccinia virus to treat intraepithelial lesions associated with papillomavirus infection [449]. The study showed promising results in terms of immune system stimulation against HPV lesions, as well as regression in intraepithelial lesions.

Summary of evidence	LE
The role of therapeutic HPV vaccination in males in terms of effectiveness and safety is limited by the small number of relevant studies.	2
Therapeutic HPV vaccination in males is moderately effective against persistent anogenital HPV16 infection [(46.9% (28.6-60.8%)] and high-grade anal intraepithelial lesions [grade 2: 61.9% (21.4-82.8%); grade 3: 46.8% (20-77.9%)].	1b

Recommendation	Strength rating
Offer HPV vaccine to males after surgical removal of high-grade anal intraepithelial neoplasia.	Weak

3.14.9 Prophylactic vaccination

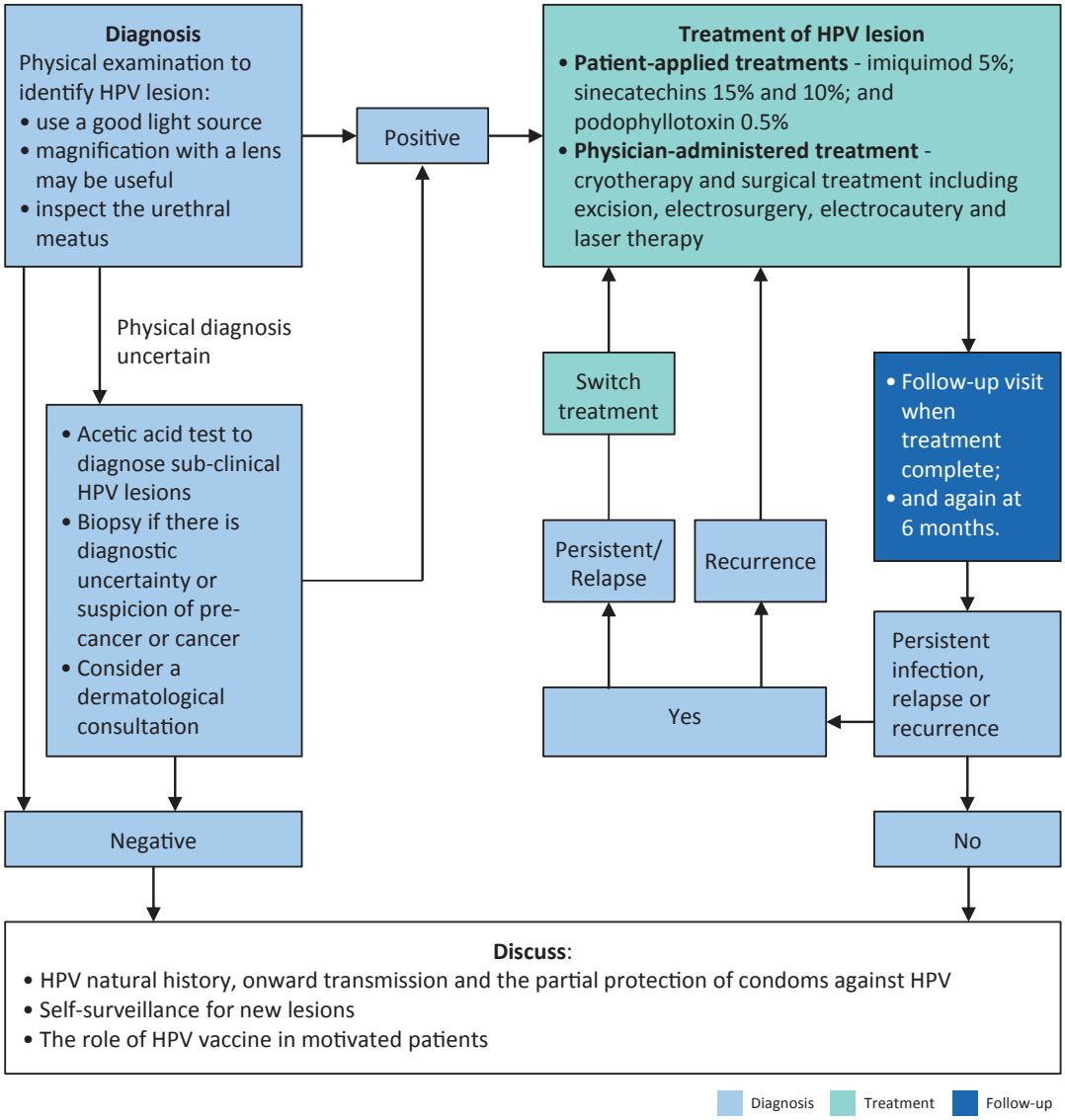
A systematic review and meta-analysis reported that vaccination is moderately effective against genital HPV-related diseases, irrespective of an individual's HPV status. However, higher vaccine efficacy was observed in HPV-naïve males thus supporting the early vaccination of boys with the goal of establishing optimal vaccine-induced protection before the onset of sexual activity [420]. An RCT including 1,124 patients demonstrated high efficacy of the quadrivalent HPV vaccine versus placebo against HPV6/11/16/18-related persistent infections [450]. Moreover, the vaccine elicited a robust immune response and was well tolerated with mild vaccination-related adverse events, such as injection-site pain and swelling [450]. In addition, a Cochrane review demonstrated that the quadrivalent HPV vaccine appears to be effective in the prevention of external genital lesions and genital warts in males [451].

Despite the fact that quadrivalent HPV vaccines were approved for use in young adult males in 2010, vaccination rates have remained low at 10-15% [452]. Barriers to uptake in this patient group include lack of awareness about HPV vaccines and HPV-related diseases, concerns about vaccine safety and efficacy, economic/cost issues related to vaccine uptake, underestimation of HPV infection risks, and sexual activity [452]. Health care professionals should provide easily understood and accessible communication resources regarding these issues to educate young adult males and their families on the importance of HPV vaccination to reduce the incidence of certain cancers later in life [452, 453].

Summary of evidence	**LE**
HPV vaccine is effective in the prevention of external genital lesions and genital warts in males.	1a
HPV vaccination is moderately effective against genital HPV-related diseases irrespective of an individual's HPV status, however, higher vaccine efficacy was observed in HPV-naïve males.	1a
A systematic review of HPV vaccination barriers among adolescent and young adult males identified a number of barriers to vaccine uptake, including fear of side effects, limited HPV awareness, financial costs and changes in sexual activity.	1b
An intervention study to evaluate whether electronic messaging can increase human papillomavirus vaccine completion and knowledge among college students concluded that intervention increased knowledge but not vaccine completion.	2b

Recommendations	**Strength rating**
Offer early HPV vaccination to boys with the goal of establishing optimal vaccine-induced protection before the onset of sexual activity.	Strong
Apply diverse communication strategies to improve HPV vaccination knowledge in young adult males.	Strong

Figure 3: Diagnostic and treatment algorithm for the management of HPV in males



3.15 Herpes simplex virus

3.15.1 Epidemiology, aetiology and pathogenesis

Genital herpes (GH) is a highly prevalent sexually transmitted, lifelong viral infection caused by the herpes simplex virus (HSV), which exists in two types: HSV-1 and HSV-2. Genital herpes accounts for up to 60% of genital ulcers, with approximately one-third caused by HSV-1 and two-thirds by HSV-2 [454]. Coinfection with both virus types occurs in up to 44.7% of patients [455]. The estimated seroprevalence of HSV-1 among healthy adults is 84.8%, while for HSV-2 it ranges from 10 to 12.44% [456-459]. Both HSV-1 and 2 result in chronic infection, with frequent reactivations and subclinical shedding, leading to a high risk of transmission to sexual partners.

Risk factors for GH include high sexual promiscuity, a large number of lifetime sexual partners, rural residence and unprotected sex [460, 461]. Increased prevalence is seen in intermediate- and high-risk subgroups, such as MSM, HIV-infected patients, those living with HIV-infected partners, STDI clinic attendees and transgender individuals [457-459].

3.15.2 Diagnosis

Clinical diagnosis of genital herpes can be challenging, as ulcerative lesions may be absent during evaluation. When present, the lesions are typically painful, erythematous, vesicular and recurrent. Less-common presentations include nodular, hypertrophic, verrucous, vegetative or exophytic lesions [462]. Whenever possible, GH diagnosis should be confirmed by laboratory testing [463]. Swabs should be taken from the lesion for type-specific virus identification using PCR or culture [462]. PCR detection of HSV DNA is rapid and more sensitive

than traditional culture and immunoassay methods [464-466]. While PCR accuracy may vary, most tests available exhibit sensitivity and specificity > 90% [467, 468]. HSV serological assays, ideally using the Western blot technique, can detect antibodies against multiple HSV-1 and HSV-2 antigens, including glycoprotein G [469-471]. However, the Panel does not recommend serological testing for diagnosing localised genital HSV infections. During the last few years, rapid point-of-care tests for serological HSV diagnosis have become available [472, 473]. Although these methods show high sensitivity and specificity, they do not provide quantitative results, making them less useful than laboratory tests. Insufficient evidence is available currently to recommend these rapid tests as the diagnostic standard in clinical practice. Serological testing is primarily indicated for detecting past HSV infections and is not recommended for diagnosing acute or recent infections, where virus detection from active lesions remains the preferred method.

*3.15.3 **Disease management***

3.15.3.a Systemic treatment

Antiviral drugs used to treat HSV include acyclovir, valacyclovir, pritelivir [474], amenamevir [475, 476], and inosine pranobex [477]. Short-term recurrence rates are high, ranging from 27 to 48% [477]. Antiviral therapies reduce both the frequency and viral load during shedding [474, 478, 479]. With treatment, the rate of viral shedding decreases from 16% to approximately 5% [474], and the presence of visible lesions is reduced from 9% to approximately 1.2% [474]. While the optimal duration of treatment is not clearly defined, beneficial effects such as the reduction of ulcerative lesions and pain can be observed even after a single dose [476].

3.15.3.b Topical treatment

Topical treatments play a limited role in managing GH, and their use is not recommended. Immunomodulation with resiquimod showed no improvement in outcomes and increased the incidence of local side effects [480]. CS21 (oxygenated glycerol triesters-based barrier genital gel) improved symptoms and slowed disease progression compared to both placebo and topical acyclovir [481]. Topical acyclovir did not outperform placebo in terms of disease progression [481].

3.15.3.c Vaccination

Numerous studies have evaluated the efficacy of therapeutic vaccines for HSV treatment and transmission prevention [482-487]. However, there is currently insufficient evidence to support their use in clinical practice.

3.15.3.d Surgical management

The impact of surgical interventions in patients with HSV remains unclear. Following circumcision, there may be an increase in viral shedding in the initial weeks due to inflammation [488]. Photodynamic therapy using a photosensitizer has shown potential in a small trial for treating recurrent lesions, however, further research is needed before it can be recommended in clinical practice [489].

*3.15.4 **Prevention, screening and contact tracing, follow-up***

Glandular exposure through circumcision has been reported to prevent HSV infections [490]. A study on the pericoital application of tenofovir gel showed a reduced HSV-2 acquisition in women [491]. However, there is insufficient data to recommend any form of pre-exposure prophylaxis with HSV antiviral medications for prevention, and it should not be offered as a preventive strategy.

In accordance with most national and international guidelines, the Panel does not recommend routine herpes testing for asymptomatic individuals. Screening is recommended only in the presence of genital symptoms potentially related to HSV or if a sexual partner has GH.

Follow-up testing is not indicated, except when there are recurrent signs and symptoms. Counselling of individuals with GH and their sexual partners is of mandatory importance to prevent transmission and cope with the infection.

Level of evidence	**LE**
Genital herpes accounts for up to 60% of genital ulcers with approximately one-third caused by HSV-1 and two-thirds by HSV-2.	2b
Detection of HSV DNA via PCR is rapid and more sensitive than traditional culture and immunoassay methods.	2a
Antiviral therapies reduce both the frequency and viral load during viral shedding.	1b
Viral shedding may temporarily increase in the weeks following circumcision due to inflammation.	3
Topical antiviral therapy does not improve clinical outcomes of HSV patients or increase local side effects, but can reduce the local viral load.	1b

Recommendations	Strength rating
Obtain a comprehensive medical history, including history of previous sexual contacts, from all patients presenting with genital ulcers potentially related to HSV.	Strong
Confirm the diagnosis with a clinical swab and type-specific virologic testing, such as PCR or culture, from the lesion.	Strong
Treat the first clinical episode of genital HSV infection.	Strong

Table 12: Treatment regimens for genital HSV infection

Antimicrobials	Dosage
Recommended therapy and dose for first clinical episode HSV	
Aciclovir	400mg orally t.i.d for 10 days OR 200mg orally five times daily for 10 days.
Valaciclovir	500mg orally b.i.d for 10 days.
Recommended therapy and dose for recurrent genital HSV	
Aciclovir	400mg orally t.i.d for five days OR 800mg b.i.d for five days OR 800mg t.i.d for two days.
Valaciclovir	500mg orally b.i.d for 3 days.

t.i.d = three times daily; b.i.d = twice daily.

3.16 Genitourinary tuberculosis

3.16.1 Epidemiology, aetiology and pathophysiology

An estimated 246,000 new and relapse tuberculosis (TB) cases occurred in the WHO European Region in 2019, with 49,752 of these cases occurring within the 31 countries comprising the European Union (EU)/ European Economic Area (EEA) region [492]. An estimated 12.0% of incident TB cases in 2019 were coinfected with HIV. Extrapulmonary TB was notified on average for 16.6% of all incident TB cases in the region. Eleven countries reported more than 30% of their TB cases having extrapulmonary localisation. The proportion of TB that is extrapulmonary is significantly greater among migrants from e.g. South-East Asia, Sub-Saharan Africa and Eastern Europe and Central Asia than non-migrants across the European Union (EU)/European Free Trade Association (EFTA). Genitourinary tuberculosis (GUTB) accounted for 4.6% of extrapulmonary TB cases in the EU between 1997 and 2017 [493]. Tuberculosis is an infectious disease caused by a group of *Mycobacterium* species called the *Mycobacterium tuberculosis* complex (MBTC) [494]. Genitourinary TB can affect all genitourinary organs and is almost always secondary due to the hematogenous spread of chronic latent TB infection (LTBI) [495]. Risk factors include primary and latent TB infection, diabetes, old age, low BMI, oncological comorbidities, immune suppression (including HIV), renal failure and poor socioeconomic living conditions. The risk of reactivation is estimated to be up to 15% during one's lifetime [496]. The WHO recommend either a tuberculin skin test (TST) or interferon-gamma release assay (IGRA) for the diagnosis LTBI [497].

3.16.2 Diagnosis

Patients generally present with non-specific urological complaints for which no obvious cause is identified, including haematuria; increased urinary frequency; difficulty voiding; abdominal, lumbar and suprapubic pain; and, in female patients, menstrual irregularities and pelvic pain. Patients may also present for infertility issues, however, infertility and TB will not be addressed in detail in this text. The diagnosis of GUTB is challenging, as no single diagnostic test exists. Diagnosis relies on a high suspicion of infection based on patient history; microbiological, molecular and histological testing; and imaging findings.

3.16.2.a Smear microscopy

Smear microscopy is a simple and cost-effective way of detecting the presence of acid-fast bacilli (AFB) in urine samples, semen, tissue specimens, pus or discharged or prostatic massage fluid, through microscopic examination using Ziehl-Neelsen or auramine staining [498, 499]. A major limitation of smear microscopy is its low sensitivity (ranging from 0 to 25%) in urine [500, 501].

3.16.2.b Culture

The culture-based method (both solid and liquid media) for biological specimens is the reference standard for *M. tuberculosis* isolation from biological samples. Three midstream, first-void urine samples on consecutive days are recommended for TB culture [499]. A disadvantage of culture-based methods is the long incubation period needed for results at least nine to ten days for positive results and six weeks to be considered negative,

as well as the need for highly equipped laboratories. In addition, studies have reported high specificities of 92-100%, but low sensitivities 23.3-30% for urine culture in renal TB specimens [502, 503].

3.16.2.c Nucleic acid amplification tests

In recent years, nucleic acid amplification tests (NAATs) have been introduced in the diagnostic pathway of TB to shorten diagnostic work-up. In 2021, the WHO issued an update to its guidelines for the rapid diagnosis of TB, in which they made a conditional recommendation that, in patients with signs and symptoms of extrapulmonary TB, Xpert MTB/RIF may be used as an initial diagnostic test [504]. Xpert MTB/RIF pooled sensitivity and specificity were 84.7% (70.8-93.1) and 97.3% (91.0-99.2) for the diagnosis of genitourinary TB [505]. The 2021 WHO guidelines also contain recommendations for additional PCR testing systems, as well as moderate complexity automated NAATs [504].

Note: Several other diagnostic tests are currently under investigation by the WHO but cannot be recommended for the diagnosis of GUTB at this time.

3.16.2.d Imaging

Imaging modalities aid in the localisation of the foci of infection in GUTB and in the assessment of the extent of the damage to the genitourinary system. Imaging techniques for the diagnosis of GUTB have a sensitivity of approximately 90% [506]. However, the quality of the evidence available for diagnostic imaging of TB is low to very low, and further studies are required to enable the Panel to make recommendations on this topic.

Ultrasound is a cost-effective and non-invasive imaging modality that has been shown to be effective for the diagnosis of testicular, epididymal and vas deferens TB [507-511]. Ultrasound examination may also allow for the identification of parenchymal masses, cavities, mucosal thickening of the collecting system and bladder, stenosis and consecutive obstruction of the collecting system, vesicoureteral reflux, and calcifications [512]. In female GUTB patients, ultrasound may identify ovarian masses, intrauterine thickening and calcifications [513].

Intravenous urography aids in the identification of renal and ureteral TB but lacks specificity. Approximately 10-15% of patients may have normal findings on intravenous urogram (IVU) [514, 515]. The most common findings on IVU are hydrocalycosis, hydronephrosis or hydroureter due to stricture, autonephrectomy and urinary calcifications [516-518].

In recent years, CT and MRI have largely replaced IUV. The most common findings on CT are parenchymal scarring, hydrocalycosis, hydronephrosis or hydroureter due to stricture, and thickening of the renal pelvis, ureter and bladder walls [516-518]. In TB of the seminal vesicles and vas deferens, CT imaging can show enlarged heterogeneously enhancing seminal vesicles with possible wall thickening, contraction and intraluminal or wall calcifications [519, 520]. Prostate TB appears as a low attenuating and marginally enhancing cystic mass that is indistinguishable from a non-TB prostatic abscess [521]. In female GUTB, the fallopian tubes are most frequently affected area and present with enlargement, hydrosalpinx, pyosalpinx and wall thickening, with calcification on CT [522].

Magnetic resonance imaging has low sensitivity for the diagnosis of GUTB in the early stages of the infection [523]. As an imaging modality, MRI is useful in patients in whom CT is contraindicated, including patients with renal failure or contrast hypersensitivity reactions or those who wish to avoid exposure to radiation. Renal and ureteral abnormalities are comparable to those described for CT findings and must be distinguished from acute pyelonephritis [513, 524]. Epididymitis and testicular TB appears as a diffusely enlarged epididymis or testis with heterogeneous high T2 signal due to fibrosis and calcification [520]. Multiparametric MRI of the prostate distinguishes between the nodular or diffuse patterns of prostate TB [525].

Female GUTB has a wide range of appearances on hysterosalpingogram (HSG) affecting the fallopian tubes, endometrium and uterus [526, 527]. Tubal obstruction is the most common finding with HSG [527]. In addition, deformity of the uterine cavity can be observed, such as a T-shaped and dwarfed uterus, resulting from abnormal scarring and fibrosis [526]. As the disease progresses this process can potentially lead to a complete obliteration of the uterine cavity referred to as Netter syndrome [528].

*3.16.3 **Medical Treatment***

The WHO recommends a six-month daily regimen for treatment of newly diagnosed extrapulmonary TB, including an intensive phase of two months with isoniazid, rifampicin, pyrazinamide and ethambutol, followed by a continuation phase of four months with isoniazid and rifampicin [529]. For the treatment of multidrug-resistant (MDR) TB (i.e. resistance to rifampicin and isoniazid), an individualised treatment regimen should be applied

with at least five effective tuberculosis medicines during the intensive phase, including pyrazinamide and four core second-line tuberculosis medicines [530].

3.16.4 Surgical treatment

Combination drug therapy is the first-line treatment for GUTB. However, in more than 50% of patients, ablative, endoscopic or reconstructive surgery is required, due to the destructive nature of the infection coupled with a delay in initial diagnosis [531-533]. A total of 26.9% of cases of diagnosed GUTB involve a non-functioning unilateral kidney and 7.4% involve renal failure [533].

In the largest observational study of 4,288 GUTB patients, a total of 2,364 different surgical procedures were carried out, 948 of which were reconstructive [534]. In a retrospective series of 241 patients who underwent surgery for GUTB, a total of 128 reconstructive procedures were performed, in which 30.29% of patients had bladder augmentation [535]. A retrospective single-centre study of 128 patients reported that kidneys affected by TB in the reconstruction group had a 5.44-times longer survival than the permanent diversion group suggesting that, when feasible, renal reconstruction may be better for renal function preservation [536]. Reconstructive surgery may include augmentation cystoplasty, uretero-ureterostomy, ureteroneocystostomy, ureteral reimplant, pyeloplasty, ureterocalicostomy and ileal ureter or external diversion, where indicated [537].

Limited evidence is available with regard to the optimum surgical approach. Minimally invasive options have been reported as feasible and safe strategies as compared to open surgery [538-542]. In addition, the optimal timing for surgery is controversial. A delay of two to six weeks up to nine months after the initiation of medical treatment has been proposed to allow for a reduction in active inflammation and stabilisation of the TB lesions [523].

Due to a lack of high-quality evidence for surgical treatment of GUTB, the Panel is unable to currently give a recommendation on surgical treatment. Patients with GUTB should be assessed on an individualised basis and the decision to operate taken depending on the location, extent of disease progression and damage to the genitourinary system.

3.16.5 Summary of evidence and recommendations for the diagnosis and treatment of GUTB

Summary of evidence	LE
The risk of reactivation of latent TB is estimated to be 15% in an individual's lifetime.	2a
Smear microscopy for acid-fast bacilli has a low sensitivity in urine ranging from 0 to 25%.	2a
Studies have reported high specificities of 92-100% but low sensitivities of 23.3-30% for urine culture in renal TB specimens.	2a
Xpert MTB/RIF pooled sensitivity and specificity were 84.7% (70.8-93.1) and 97.3% (91.0-99.2) for the diagnosis of GUTB.	1b
Standard six-month anti-tuberculous drug regimens are effective in all forms of TB (pulmonary and extrapulmonary).	1a
There is limited evidence with regard to the optimum surgical approach and timing of surgery in GUTB patients.	3

Recommendations	Strength rating
Diagnosis	
Take a full medical history, including history of previous tuberculosis (TB) infection (pulmonary and extrapulmonary), from all patients presenting with persistent non-specific genitourinary symptoms and no identifiable cause.	Strong
Perform smear microscopy on urine, semen, tissue specimens and discharged or prostatic massage fluid using Ziehl-Neelsen (ZN) or auramine staining in patients with suspected genitourinary tuberculosis (GUTB).	Weak
Perform an acid-fast bacilli culture on three midstream first-void urine samples, on three consecutive days for *M. tuberculosis* isolation in patients with suspected GUTB.	Strong
Use a recommended PCR test system in addition to the microbiological reference standard (MRS) in urine specimens as a diagnostic test in patients with signs and symptoms of GUTB.	Weak

Use imaging modalities in combination with culture and/or PCR to aid in the diagnosis of GUTB and to assess the location and extent of damage to the genitourinary system.	Weak
Treatment	
Use medical treatment as first-line treatment for GUTB.	Strong
Use a daily six-month regimen for treatment of newly diagnosed GUTB. This should include an intensive phase of two months with isoniazid, rifampicin, pyrazinamide and ethambutol, followed by a continuation phase of four months with isoniazid and rifampicin.	Strong
Treat multidrug-resistant TB with an individualised treatment regimen including at least five effective tuberculosis medicines during the intensive phase, including pyrazinamide and four core, second-line tuberculosis medicines.	Strong

Table 13: Treatment regimens for newly diagnosed GUTB and MDR-TB [530]

Antimicrobials	Dosage
Six-month regimen for treatment of newly diagnosed GUTB	
Intensive two-month phase	
Isoniazid	5mg/kg q.d; max. daily dosage 300mg
Rifampicin	10mg/kg q.d; max. daily dosage 600mg
Pyrazinamide	25mg/kg q.d; max. daily dosage 2,000mg
Ethambutol	15-20mg/kg q.d; max. daily dosage ranging from 800mg to 1,600mg, depending on body weight
Continuation four-month phase	
Isoniazid	5mg/kg q.d; max. daily dosage 300mg
Rifampicin	10mg/kg q.d; max. daily dosage 600mg
Treatment regimen for multidrug-resistant TB	
Treat multidrug-resistant TB with an individualised treatment regimen including at least five effective tuberculosis medicines during the intensive phase, including pyrazinamide and four core, second-line tuberculosis medicines*.	
Group A Fluoroquinolones	Levofloxacin, Moxifloxacin and Gatifloxacin
Group B Second-line injectables	Amikacin, Capreomycin, Kanamycin and Streptomycin**
Group C Other second-line agents	Ethionamide/ Prothionamide, Cycloserine/Terizidone, Linezolid and Clofazimine
Group D Add-on agents (not part of the core MDR-TB regimen)	D1: Pyrazinamide, Ethambutol and High-dose isoniazid D2: Bedaquiline and Delamamid D3: p-aminosalicylic acid, Imipenem-cilastatin, Meropenem, Amoxicillin-clavulanate and Thioacetazone***

b.i.d. = twice daily; t.i.d. = three times daily; q.d. = every day; o.d. = once daily.
** Drugs should be chosen as follows: one from group A, one from group B and at least two from group C. If the minimum number of five TB medicines cannot be composed from drugs included in Groups A to C, an agent from group D2 and other agents from group D3 can be added to bring the total to five [530].*
***Streptomycin can substitute other injectable drugs if none of these agents can be used and if the strain is shown not to be resistant [530].*
***Thioacetazone should not be used if the patient is HIV seropositive [530].*

3.17 Fungal urinary tract infection

3.17.1 Epidemiology and risk factors

Only 2-11% of patients with funguria present with symptoms of a UTI [543, 544]. The prevalence of funguria is considerably higher in hospital-acquired settings than in outpatient environments, ranging from < 1% in outpatients to 5-10% of positive urine cultures in hospitalised patients [545, 546]. In a large multicentre European study evaluating urine cultures of UTIs, *Candida* species were the third most common pathogen, accounting for 9.4% of specimens [547]. The incidence of funguria and fungal UTI is particularly high among ICU patients but is subject to regional variations [548, 549].

Candida albicans is the predominant fungal uropathogen accounting for 50-70% of all urinary fungal isolates, while *Candida glabrata* and *Candida tropicalis* together account for 10-35%. However, their prevalence varies depending on geographic region and patient population [543, 550]. Less common species include *Candida parapsilosis* and *Candida krusei* [543]. *Candidozyma auris*, an emerging multidrug-resistant pathogen associated with high mortality, is only rarely detected in urine [551-553]. Isolation of non-*Candida* fungal species from urine cultures is uncommon.

Well-established risk factors for fungal UTIs include female sex, advanced age, and comorbidities, such as diabetes mellitus, urinary tract abnormalities, chronic liver disease, renal insufficiency, malignancy, immunosuppression, and malnutrition [554-557]. Fungal UTIs are strongly associated with urinary tract instrumentation and indwelling catheters or drains [543, 558-560]. After radical cystectomy, *Candida* spp. rank among the second to third most common pathogens in postoperative UTIs [561, 562]. One further risk factor is prior exposure to broad-spectrum antibiotics or antifungals [554, 563].

3.17.2 ***Clinical presentation and diagnosis***

3.17.2.a Clinical presentation

The presence of fungi in urine represents a spectrum of clinical conditions from asymptomatic colonisation to systemic infection such as life-threatening urosepsis. Most fungal UTIs present as localised UTIs (i.e. cystitis). Since *Candida* spp. adhere poorly to the bladder urothelium, cystitis usually requires predisposing factors, such as urinary obstruction, immunosuppression or biofilm formation on indwelling devices. Infection may extend to the upper urinary tract either by ascending spread from the bladder, particularly in case of reflux or obstruction (including fungal balls), resulting in fungal pyelonephritis, or by hematogenous dissemination with direct invasion of the renal tubules [545].

3.17.2.b Symptoms

In patients with funguria, only 2-11% present with typical UTI symptoms [543, 544]. Fungal UTI should only be considered in symptomatic cases. However, many patients with funguria are in intensive care or long-term care settings, where symptom assessment is unreliable. These patients are frequently unable to report symptoms, and long-term catheters obscure typical signs such as frequency or dysuria [564].

3.17.2.c Urine culture and urinalysis

The diagnostic standard is urine culture, although colony count thresholds distinguishing colonisation from infection remain undefined [564, 565]. Similar to bacterial UTIs, a cut-off of $\geq 10^5$ CFU/mL is frequently reported in studies [554, 566-570]. Susceptibility testing should be performed, particularly in non-albicans *Candida* spp. It should be noted that some *Candida* spp., such as *Candida glabrata*, may grow poorly on routine media or require prolonged incubation, and additional diagnostic measures (e.g. subculturing on selective fungal media or molecular identification) may therefore be warranted when infection is suspected, but cultures remain negative [571].

Repeating cultures using a freshly catheterised specimen or after device removal can help to distinguish contamination from funguria, while the presence of symptoms confirms infection [567].

Pyuria may suggest infection but lacks specificity, particularly in catheterised or elderly patients. The greatest value of pyuria therefore lies in its negative predictive ability, as the absence of pyuria makes a UTI unlikely, and instead suggests that a positive culture result is due to contamination [572, 573].

3.17.2.d Alternative markers

Several studies have assessed additional diagnostic markers for fungal UTIs, but none have demonstrated sufficient clinical utility. Elevated Interleukin-17 levels correlate with funguria, but fails to distinguish colonisation and infection and therefore has no diagnostic role [544].

3.17.2.e Imaging

Imaging is reserved for symptomatic patients to identify infection site and complications. Ultrasound can detect pyelonephritis, abscesses, fungal balls and hydronephrosis. Typical findings may include calyceal wall thickening, increased renal vascularity or loss of corticomedullary differentiation. Fungal balls appear as echogenic debris without Doppler flow, while hydronephrosis suggests obstruction [574]. Computed tomography urography provides greater sensitivity for pyelonephritis, abscesses, emphysematous infections and obstruction, while MRI with contrast or renal cortical scintigraphy (Tc-99m DMSA) can be used in selected cases [565, 575].

3.17.3 ***Treatment***

3.17.3.a Asymptomatic funguria

Asymptomatic funguria generally requires no antifungal treatment, but should be considered in neutropenic patients, infants with birth weights < 1,500g or before urological intervention breaching the mucosa [576, 577]. Patients with asymptomatic candiduria may have an underlying disorder or defect.

3.17.3.b Treatment of fungal urinary tract infections

Non-antimicrobial measures should be implemented whenever necessary. For example, catheter replacement alone can lead to a significant clearance of funguria [578]. In cases of urinary tract obstruction, prompt drainage with ureteral stent placement or percutaneous nephrostomy should be performed [579].

Treatment depends on the isolated species and its susceptibility pattern recommended agents include fluconazole, amphotericin B deoxycholate, and oral flucytosine, with weight-based dosing critical for efficacy [576, 580]. Species-specific resistance must be considered. *C. krusei* and *C. glabrata* are > 90% fluconazole resistant and a species-specific resistance can be assumed. Clinical data indicate that *C. glabrata* UTI can only be treated with fluconazole if the isolate is confirmed to be fluconazole-susceptible, as resistance rates are high and vary by region and patient population. Large surveillance studies have shown that *C. glabrata* isolates from urine often have higher fluconazole minimum inhibitory concentrations (MICs) than those from other sites, with resistance rates in some cohorts exceeding 15% and a significant proportion of isolates falling into the susceptible-dose dependent (SDD) category, requiring higher dosing for efficacy [581].

Moreover, substance specifics must be considered. For example, echinocandins (e.g. caspofungin) have poor urinary penetration and are unsuitable for fungal cystitis but achieve high renal tissue levels, making them useful for pyelonephritis. However, the echinocandin micafungin can reach therapeutic levels in bladder tissue despite low urinary excretion and could be considered for treatment of fungal cystitis in exceptional cases such as infections by fluconazole-resistant species such as *C. glabrata*, *C. krusei and C. auris* [582-584].

Empirical therapy usually consists of a two-week course of oral fluconazole, starting with a one-time double loading dose on the first day, followed by a daily maintenance dose [576]. In a retrospective single-centre study of hospitalised adults with fungal UTI (n = 103), clinical success rates were similar for 14-day (93.3%, 42/45) and shorter fluconazole courses (< 14 days) (93.1%, 54/58), suggesting shorter antifungal regimens might be sufficient. However, subgroup analysis distinguishing local from systemic UTI was not performed [585]. Other azoles such as ketoconazole and voriconazole achieved urine clearance of candiduria in small case series only [586, 587]. Rising fluconazole resistance and non-fluconazole-susceptible *Candida* spp. are being detected more frequently [566, 588]. One laboratory-based study reported a significant increase in the rate of fluconazole resistance among *Candida* isolates obtained from urine specimens, increasing from 6.8% in 2010-2011 to 29.5% in 2012-2013, with persistently elevated rates thereafter [581]. This highlights the need for alternative treatments.

Bladder irrigation with amphotericin B deoxycholate is described as an alternative option for fungal cystitis. A meta-analysis published in 2009 found 80-90% fungal clearance within 24 hours and superiority to fluconazole (OR 0.57, 95% CI 0.32-1.00) but included only asymptomatic funguria. [589]. In one study of 95 patients with fungal cystitis, amphotericin B deoxycholate bladder instillations (25mg in 500mL dextrose in water at 42mL/hour) for a median of five days (range 2-11) achieved 80% eradication [568]. In an RCT of fungal UTI, amphotericin B deoxycholate bladder instillation achieved early clearance in 96% of patients compared with 73% for fluconazole. However, one-month mortality was higher in the amphotericin group (41% vs. 22%), suggesting local therapy may be linked to poorer survival [568]. Continuous irrigation with 50mg/L amphotericin B deoxycholate for five days may be considered in localised fluconazole-resistant cases. Careful patient selection is necessary to exclude upper tract or systemic spread before use.

In a retrospective study (n = 33), micafungin showed a high rate of microbiological eradication for *C. albicans*, *C. glabrata* and *C. krusei* in candiduria and UTI, though no UTI-specific analysis was performed [570].

3.17.4 ***Sodium-glucose cotransporter 2 inhibitors and fungal cystitis***

Sodium-glucose cotransporter 2 (SGLT2) inhibitors may increase the risk of urogenital infections, especially genital mycotic infections [590], due primarily to their mechanism of action, which increases urinary glucose excretion (glucosuria), creating a nutrient-rich environment that can promote bacterial growth in the urinary tract [591]. However, the overall increase in UTI risk with SGLT2 inhibitors is modest and not consistently observed across all agents or patient populations. Most meta-analyses and large cohort studies show no significant difference in UTI rates compared to other antidiabetic drugs, except for a dose-dependent increase with

dapagliflozin [590, 592-594]. Fungal cystitis has been rarely reported. One retrospective observational cohort study of type 2 diabetic patients with advanced chronic kidney disease under either SGLT2 inhibitors or control treatment found a UTI rate of 19.9% in the SGLT2 inhibitor arm versus 24.0% in the control arm. Overall, the majority of UTIs were caused by Gram-negative organisms (n = 752), followed by mixed growth (n = 663), Gram-positive (n = 162) and fungal organisms (n = 160). The SGLT2 inhibitors group developed a lower rate of Gram-negative organisms related UTI ($p < 0.001$) but a higher rate of fungal UTI, which was predominantly caused by *Candida* spp. infection ($p < 0.001$) [595]. In an insurance-based study comparing SGLT2 inhibitors with glucagon-like peptide-1 receptor agonists, *Candida* and non-*Candida* UTI rates were 2.2% and 6.3% among patients on SGLT2 inhibitors, versus 0.9% and 8.0% among those on glucagon-like peptide-1 receptor agonists [596].

Summary of evidence	**LE**
Only 2-11% of patients with funguria present with symptoms of a UTI. The incidence of funguria and fungal UTI is particularly high among ICU patients.	2b
Evaluation of classical UTI symptoms combined with urine culture remains the primary diagnostic approach.	2a
Asymptomatic funguria usually does not require treatment, except in neutropenic patients, infants with very low birth weight or those undergoing mucosa breaching urological procedures.	2b
Empirical therapy typically consists of oral fluconazole for two weeks, starting with a double loading dose on day one, followed by daily maintenance. Rising fluconazole resistance and non-fluconazole-susceptible *Candida* spp. are being detected more frequently.	1b

Recommendations	**Strength rating**
Take a full medical history, including UTI symptoms and risk factors for fungal UTI.	Strong
Perform urine culture for species identification and susceptibility testing, particularly in non-albicans *Candida* UTI.	Strong
Replace indwelling catheters or stents for significant clearance of funguria.	Weak
Treat localised fungal UTI with a two-week course of oral fluconazole.	Strong
A treatment duration of less than two weeks can be used in localised fungal UTI (i.e. cystitis) without risk factors.	Weak
Treat fluconazole-resistant *Candida spp.* in localised UTI with amphotericin B deoxycholate instillations, amphotericin B deoxycholate instillations IV, flucytosine or capsofungin, taking in account comorbidities and kidney function.	Strong
Treat fluconazole-resistant *Candida spp.* in systemic UTI with amphotericin B deoxycholate instillations IV, flucytosine or capsofungin, taking in account comorbidities and kidney function.	Strong

Localised fungal UTI			
Pathogens	**Antimicrobial**	**Dose & Duration of therapy**	**Renal function correction**
Fluconazole-susceptible species	Fluconazole	• 200 mg/day p.o for two weeks • 800 mg/day p.o for susceptible *C. glabrata*	• CrCl < 50 mL/min: Reduce dose by 50% • Dialysis patients: Administer a full dose three times weekly after dialysis
Fluconazole-resistant species	Amphotericin B deoxycholate	Bladder instillations: 200 ml/L in a 100 ml infusion bag of 5% glucose, three times daily for seven days.	No dosage adjustment required
Fluconazole-susceptible species	Flucytosine	• 25 mg/kg p.o or IV four times daily for two weeks • Can be used as monotherapy for *C. glabrata*	• CrCl 21-40: 25 mg/kg b.i.d • CrCl 10-20: 25 mg/kg daily. • CrCl < 10: 25 mg/kg Q 48h. • Dialysis: 25-50 mg/kg Q

Fluconazole-susceptible species	Amphotericin B deoxycholate	• 0.3-0.6 mg/kg/day IV for one to seven days • Used with or without flucytosine for *C. glabrata*	No dosage adjustment required
	Caspofungin	70 mg IV day 1, then 50 mg daily for two to three weeks.	No dosage adjustment required
Systemic fungal UTI			
Fluconazole-susceptible species	Fluconazole	• 200-400 mg/day p.o for two weeks • 800 mg/day p.o for two weeks for susceptible *C. glabrata* • Severe infections: Consider a loading dose of 400/800 mg on first day	• CrCl < 50 mL/min: Reduce dose by 50% • Dialysis: Administer a full dose three times weekly after dialysis
Fluconazole-resistant species	Amphotericin B deoxycholate	• 0.3-0.6 mg/kg/day IV for one to seven days. • Used with or without flucytosine for *C. glabrata*	No dosage adjustment required
	Flucytosine	• 25 mg/kg p.o or IV four times daily for two weeks • Generally used in combination with Amphotericin B	• CrCl 21-40 mL/min: 25 mg/kg b.i.d • CrCl 10-20 mL/min: 25 mg/kg daily • CrCl < 10 mL/min: 25 mg/kg Q 48 h • Dialysis: 25-50 mg/kg/dose every 48-72 hours after dialysis.
	Caspofungin	70 mg IV day 1, then 50 mg daily for two to three weeks	No dosage adjustment required

b.i.d = twice daily; CrCl = creatinine clearance; IV = intravenous; p.o. = orally.

3.18 Periprocedural antibiotic prophylaxis

3.18.1 General Principles

3.18.1.a Definition of infectious complications

The European Centre for Disease Prevention and Control (ECDC) and the United States Centers for Disease Control and Prevention (CDC) have both presented similar definitions recommended for the evaluation of infectious complications [597, 598].

3.18.1.b Non-antibiotic measures for asepsis

A number of non-antibiotic measures have been designed to reduce the risk of surgical site infection (SSI), many of which are historically part of the routine of surgery. The effectiveness of measures tested by RCTs are summarised in systematic reviews conducted by the Cochrane Wounds Group (http://wounds.cochrane.org/news/reviews). Urological surgeons and the institutions in which they work should consider and monitor maintenance of an aseptic environment to reduce risk of infection from pathogens within patients (microbiome) and from outside the patient (nosocomial/healthcare-associated). This should include the use of correct methods of instrument cleaning and sterilisation, frequent and thorough cleaning of operating rooms and recovery areas, and thorough disinfection of any contamination. The surgical team should prepare to perform surgery by effective handwashing [599], donning of appropriate protective clothing, and maintenance of asepsis. These measures should continue as required in recovery and ward areas.

Patients should be encouraged to shower preoperatively, but the use of chlorhexidine soap does not appear to be beneficial [600]. Although evidence quality is low, any required hair removal appears best done by clipping - as opposed to shaving - just prior to incision [601]. Mechanical bowel preparation should not be used, because evidence review suggests harm rather than benefit [602, 603]. Some weak evidence is available showing that skin preparation using alcoholic solutions or chlorhexidine result in a lower rate of SSI than iodine solutions [604]. Studies on the use of plastic adherent drapes showed no evidence of benefit in reducing SSI [605].

3.18.1.c Detection of bacteriuria prior to urological procedures

Identifying bacteriuria prior to diagnostic and therapeutic procedures aims to reduce the risk of infectious complications by controlling any preoperatively detected bacteriuria and to optimise antimicrobial coverage in conjunction with the procedure. A systematic review of the evidence identified eighteen studies comparing the diagnostic accuracy of various index tests (dipstick, automated microscopy, dipslide culture and flow cytometry) with urine culture as the reference standard [606]. The systematic review concluded that none of the alternative urinary investigations for the diagnosis of bacteriuria in adult patients prior to urological interventions can currently be recommended as an alternative to urine culture [606].

3.18.1.d Choice of agent

Urologists should have knowledge of local pathogen prevalence for each type of procedure, their antibiotic susceptibility profiles and virulence to establish written local guidelines. These guidelines should cover the five modalities identified by the ECDC following a systematic review of the literature [607]. The agent should ideally not be one that may be required for treatment of infection. When risk of skin wound infection is low or absent, an aminoglycoside (gentamicin) should provide cover against likely uropathogens, provided the eGFR is > 20mL/min; second generation cephalosporins are an alternative [608]. Recent urine culture results, including presence of any multidrug-resistant organisms, drug allergy, history of *C. difficile* associated diarrhoea, recent antibiotic exposure, evidence of symptomatic infection pre-procedure, and serum creatinine should be checked. The Panel have decided not to make recommendations for specific agents for particular procedures, because there is considerable variation in Europe and worldwide regarding bacterial pathogens, their susceptibility and availability of antibiotic agents.

*3.18.2 **Specific procedures and evidence question***

An updated literature search from February 2017 (cut-off of last update) to June 2021 identified RCTs, systematic reviews and meta-analyses that investigated the benefits and harms of using antibiotic prophylaxis prior to specific urological procedures. The available evidence enabled the panel to make recommendations concerning urodynamics, cystoscopy, stone procedures (extracorporeal shockwave lithotripsy [ESWL], ureteroscopy and percutaneous nephrolithotomy [PCNL]), transurethral resection of the prostate (TURP) and transurethral resection of the bladder (TURB). For nephrectomy and prostatectomy, the scientific evidence was too weak to allow the Panel to make recommendations either for or against antibiotic prophylaxis. The general evidence question was: Does antibiotic prophylaxis reduce the rate of postoperative symptomatic UTI in patients undergoing each named procedure?

3.18.2.a Urodynamics

The literature search identified one systematic review for antibiotic prophylaxis in females only [609]. This included three RCTs (n = 325 patients) with the authors reporting that prophylactic antibiotics reduced the risk of bacteriuria but not clinical UTI after urodynamics [609]. A previous Cochrane review identified nine RCTs enrolling 973 patients with overall low quality and high or unclear risks of bias [610]. The outcome of clinical UTI was reported in four trials, with no benefit found for antibiotic prophylaxis versus placebo [RR (95% CI) 0.73 (0.52-1.03)]. A meta-analysis of nine trials showed that the use of antibiotics reduced the rate of post-procedural bacteriuria [RR (95%CI) 0.35 (0.22-0.56)] [610].

3.18.2.b Cystoscopy

Three systematic reviews and meta-analyses [611-613] and one additional RCT [614] on cystoscopy for stent removal were identified. Garcia-Perdomo *et al.* included seven RCTs with a total of 3,038 participants. The outcome of symptomatic UTI was measured by five trials of moderate overall quality and meta-analysis showed a benefit for using antibiotic prophylaxis [RR (95% CI) 0.53 (0.31-0.90)]; ARR 1.3% (from 2.8% to 1.5%) with a NNT of 74 [612]. This benefit was not seen if only the two trials with low risk of bias were used in the meta-analysis. Carey *et al.* included seven RCTs with 5,107 participants. Six trials were included in meta-analysis of the outcome of symptomatic bacteriuria, which found benefit for use of antibiotic prophylaxis [RR (95% CI) 0.34 (0.27-0.47)]; ARR 3.4% (from 6% to 2.6%) with NNT of 28 [611]. Zeng *et al.* included twenty RCTs and two quasi-RCTs with a total of 7,711 participants. The outcome of symptomatic UTI was measured by eleven RCTs of low overall quality and meta-analysis showed a possible benefit for using antibiotic prophylaxis [RR 95% CI 0.49 (0.28-0.86)] [613]. For systemic UTI, antibiotic prophylaxis showed no effect compared with placebo or no treatment in five RCTs [RR (95% CI) 1.12 (0.38-3.32)]. However, prophylactic antibiotics may increase bacterial resistance [RR (95% CI) 1.73 (1.04-2.87)].

Given the low absolute risk of postprocedural UTI in well-resourced countries, the high number of procedures being performed, and the high risk of contributing to increasing antimicrobial resistance, the Panel consensus was to strongly recommend not to use antibiotic prophylaxis in patients undergoing urethrocystoscopy (flexible or rigid).

3.18.2.c Interventions for urinary stone treatment

3.18.2.c.1 Extracorporeal shockwave lithotripsy

For patients without bacteriuria undergoing ESWL, two systematic reviews and meta-analyses were identified with latest search dates of November 2011 and October 2012, respectively [615, 616], and two further trials [617]. Lu *et al.* included nine RCTs with a total of 1,364 patients and found no evidence of benefit in terms of reducing the rate of postprocedural fever or bacteriuria [615]. Mrkobrada *et al.*, included eight RCTs with a total of 940 participants and found no evidence of benefit for antibiotic prophylaxis to reduce rate of fever or trial-defined infection [616]. An RCT with 274 patients and severe risk of bias found no reduction in fever at up to one week post-procedure using a single dose of levofloxacin 500mg and no difference in the rate of bacteriuria [617]. Another RCT (n = 600), again with severe risk of bias, found no difference in UTI and positive urine culture rates at two weeks post-procedure using 200mg ofloxacin postoperatively for three days versus placebo [618].

For patients with bacteriuria or deemed at high risk of complications, one RCT comparing the use of ofloxacin or trimethoprim-sulfamethoxazole for three days prior and four days subsequent to ESWL in 56 patients with ureteric stents was identified [619]. The RCT found no difference in rate of clinical UTI at seven days (no events) and no difference in post-ESWL bacteriuria.

A large RCT (n = 1,694) evaluated single-dose ciprofloxacin for preventing postoperative infectious complications [620]. The composite primary outcome occurred in 2.7% in the ciprofloxacin group versus 3.9% in the placebo group (RR 0.68, 95% CI 0.41-1.15), indicating no statistically significant difference. Symptomatic UTI was observed in 1.3% versus 2.7% (RR 0.49, 95% CI 0.19-1.23), again without statistical significance and with wide confidence intervals. Pyelonephritis occurred in none of the ciprofloxacin patients and in nine placebo patients (1.2%; RR 0.05, 95% CI 0.003-0.93), suggesting a possible effect but with a very small absolute risk reduction. No urosepsis or deaths occurred. Overall, the absolute benefit of single-dose ciprofloxacin is limited, and its use must be interpreted in the context of the legally binding EU restrictions on fluoroquinolones (see section 3.4.4.b and EMA Article-31 referral [154]) and antimicrobial stewardship.

3.18.2.c.2 Ureteroscopy

One updated systematic review and meta-analysis with last search date of June 2017 was identified and included eleven RCTs with 4,591 patients [621]. The meta-analysis found that postoperative pyuria and bacteriuria rates were significantly lower in patients who received preoperative antibiotic prophylaxis (OR: 0.42, 95% CI 0.25-0.69 and OR: 0.25, 95% CI 0.11-0.58, respectively). Five studies assessed postoperative febrile UTI (fUTI) and found no difference in the rate of fUTIs among patients who did or did not receive antibiotic prophylaxis (OR: 0.82, 95% CI 0.40-1.67; p = 0.59). However, a significantly higher risk of postoperative fever in the preoperative antibiotic prophylaxis group (OR: 1.75, 95% CI 1.22-2.50; p = 0.002) was reported. A subgroup analysis on the type of preoperative antibiotic prophylaxis found no difference between a single dose of oral versus intravenous antibiotics [621].

An RCT comparing various ciprofloxacin-based antibiotic prophylaxis regimens on the incidence of systemic inflammatory response syndrome (SIRS) after URS found no difference in the incidences of SIRS among the regimens, including the zero-dose regimen [622]. There was, however, a greater risk of SIRS in patients who did not receive antibiotic prophylaxis when the stone size was > 200mm^2 [622]. Another RCT comparing the use of two oral doses of 3g fosfomycin tromethamine before surgery to standard of care did not find any difference in the incidence of infections, bacteriuria or fever [623].

Panel discussion considered that, despite low-quality evidence suggesting no benefit in reducing risk of clinical UTI, clinicians and patients would prefer to use prophylaxis to prevent kidney infection or sepsis. Ideally this should be examined in a robustly designed clinical study.

3.18.2.c.3 Percutaneous nephrolithotomy (PNL)

The largest systematic review and meta-analysis performed, with latest search date April 2019, included 1,549 patients in thirteen comparative studies on antibiotic prophylaxis strategies for PNL [624]. Compared with a single dose before surgery, preoperative antibiotic prophylaxis significantly reduced postoperative sepsis and fever (OR 0.31, 95% CI 0.20-0.50 and OR 0.26, 95% CI 0.14-0.48, respectively) [624]. Similarly, the rate of positive pelvic urine and positive stones culture were reduced when preoperative prophylaxis was given. No difference in sepsis rates was observed among patients receiving or not receiving postoperative prophylaxis. However, patients who received postoperative antibiotic prophylaxis experienced fever more often [624].

Four RCTs with overall low risk of bias comparing various antibiotic regimes in PNL were identified [625-628]. Seyrek *et al.* compared the rate of SIRS following PNL in 191 patients receiving either a combination of

sulbactam/ampicillin or cefuroxime. No difference was observed in SIRS or urosepsis rates [625]. Tuzel *et al.* investigated single-dose ceftriaxone versus ceftriaxone and subsequently an oral third-generation cephalosporin until after nephrostomy catheter withdrawal at mean (SD) of three (1) days in 73 participants undergoing PNL. The researchers found no difference in rate of infectious complications between the two antibiotic regimens [626]. Taken *et al.* compared the administration of 1g ceftriaxone and 1g cefazoline both administered 30 minutes before surgery and continued until nephrostomy removal. They found no difference in terms of SRIS or sepsis between the groups [628]. Omar *et al.* compared ciprofloxacin 200mg IV versus 2mg cefotaxime 30 minutes before and 12 hours after surgery and found a higher rate of fever in the cefotaxime group [627]. However, these results remain limited by the high risk of bias and the lack of data regarding postoperative infection. These studies give moderate evidence that a single dose of a suitable agent was adequate for prophylaxis against clinical infection after PNL.

3.18.2.d Transurethral resection of the prostate

A systematic review of 39 RCTs with a search date cut-off in 2009 was identified [629]. A subsequent updated search to February 2017 did not reveal any further relevant studies. Of the 39 RCTs reviewed by Dahm *et al.*, six trials involving 1,666 males addressed the risk of septic episodes, 17 trials reported procedure-related fever and 39 investigated bacteriuria. The use of prophylactic antibiotics compared to placebo showed a relative risk reduction (95% CI) for septic episode of 0.51 (0.27-0.96) with ARR of 2% (3.4%-1.4%) and an NNT of 50. The risk reduction (95% CI) for fever was 0.64 (0.55-0.75) and 0.37 (0.32-0.41) for bacteriuria.

3.18.2.e Transurethral resection of the bladder

One systematic review that included seven trials with a total of 1,725 participants was identified [630]. Antimicrobial prophylaxis showed no significant effect on postoperative UTIs [OR 95% CI 1.55 (0.73-3.31)] and asymptomatic bacteriuria [OR (95% CI) 0.43 (0.18-1.04)] [630]. The review did not attempt subgroup analysis according to presence of risk factors for postoperative infection such as tumour size. Risk factors for development of postoperative UTIs were evaluated only by three of the included studies, and most of the parameters were analysed by no more than one study.

An RCT (n = 100) comparing oral fosfomycin 3g (the night before surgery) versus intravenous cefoxitin 2g (30 min. pre-surgery and 24 hours post-surgery) on postoperative UTIs found that a single oral administration of fosfomycin was noninferior to intravenous administration of cefoxitin in the prevention of post-TURB UTI, even in patients considered to be at higher risk [631].

Panel discussion concluded that a weak recommendation to use antibiotic prophylaxis for patients undergoing TURB who had a high risk of suffering postoperative sepsis would be appropriate.

3.18.2.f Midurethral slings

One systematic review and meta-analysis identified one study assessing the role of preoperative antibiotics for midurethral sling surgery alone [632]. The study was halted due to low rate of infectious outcomes seen at the first scheduled interim analysis. The study enrolled 29 females in the antibiotic prophylaxis (cefazolin) group and 30 in the placebo group with a total follow-up of six months. No statistically significant difference between the cefazolin and placebo groups, with respect to wound infections [1 (3.3%) and 0 (0%)] or bacteriuria [3 (10%) and 1 (3.5%)] was found [632].

3.18.2.g Renal tumour ablation (radiofrequency ablation, cryoablation, and microwave ablation of renal masses)

One systematic review publication dated 2018 included 6,952 patients across 51 studies [633]. Infectious complications were reported in 74 patients, including fever (60.8%), abscess (21.6%) and UTI (8.1%). Prophylactic antibiotic use was reported in 5.4% of patients, but it was not possible to study the association of prophylactic antibiotic use to infectious complications due to lack of reporting.

3.18.2.h Prostate biopsy

3.18.2.h.1 Transperineal prostate biopsy

An updated meta-analysis of five RCTs [634-639] was performed by the panel [640]. A total of thirteen randomised studies including 4,516 patients compared the impact of biopsy route on infectious complications. Infectious complications were significantly higher following transrectal biopsy (76 events among 2,243 men) compared to transperineal biopsy (35 events among 2,273 men) [RR 95% CIs 2.00 (1.23-3.27)] [634-636, 638-641]. Another systematic review and meta-analysis of 10 RCTs (4,188 biopsies) compared infectious outcomes and antibiotic use between transrectal and transperineal prostate biopsy. Transperineal biopsy was associated with significantly lower rates of postprocedural infection-related hospitalisation (OR 0.23 95% CI 0.10-0.54) and

fever (OR 0.68 95% CI 0.52-0.89) than transrectal biopsy [642]. In addition, a systematic review including 165 studies with 162,577 patients described sepsis rates of 0.1% and 0.9% for transperineal and transrectal biopsies, respectively [643]. Finally, a population-based study from the UK (n = 73,630) showed lower readmission rates for sepsis in patients who had transperineal versus transrectal biopsies (1.0% vs. 1.4%, respectively) [644]. The available evidence demonstrates that the transrectal approach should be abandoned in favour of the transperineal approach despite any possible logistical challenges.

It should be noted that three of the current RCTs comparing transrectal biopsy with transperineal biopsy did not use any antibiotics at all in the transperineal groups [638, 645, 646]. A systematic review and meta-analysis of 23 studies (only two RCTs) including 12,324 patients reported no significant differences between patients receiving or not receiving antibiotic prophylaxis in terms of post-biopsy sepsis (0.16% vs. 0.13%) and hospitalisation due to infectious complications (0.35% vs. 0.29%) for the transperineal approach [647]. This is in line with another systematic review and meta-analysis of 112 individual patient cohorts, which also showed no significant difference in the number of patients experiencing post-transperineal biopsy infection with 1.35% of 29,880 patients receiving antibiotic prophylaxis and 1.22% of 4,772 not receiving antibiotic prophylaxis (p = 0.8) [648]. In addition, two recently published RCTs have reported comparably low post-biopsy infection rates for transperineal biopsy, regardless of whether or not antibiotic prophylaxis was administered [649, 650].

There is, therefore, a growing body of evidence to suggest that antibiotic prophylaxis may not be required for transperineal biopsy for patients at low risk of infectious complications.

3.18.2.h.2 ***Transrectal prostate biopsy***

An updated meta-analysis of twelve RCTs including 2,437 males showed that the use of a rectal povidone-iodine preparation before biopsy, in addition to antimicrobial prophylaxis, resulted in a significantly lower rate of infectious complications [RR (95% CI) 0.47 (0.36-0.61) [640, 651-654]. A meta-analysis of two RCTs with 350 patients demonstrated no significant advantage of using chlorhexidine for rectal preparation compared to saline/no rectal preparation [RR (95% CI) 0.33 (0.11-1.00)] [652, 654]. Single RCTs showed no evidence of benefit for perineal skin disinfection [655], but reported an advantage for rectal povidone-iodine preparation before biopsy compared to after biopsy [656]. Routine surgical disinfection of the perineal skin before performing a transperineal biopsy is therefore recommended.

A meta-analysis of four RCTs including 671 males evaluated the use of rectal preparation by enema before transrectal biopsy. No significant advantage was found regarding infectious complications [RR (95% CI) 0.96 (0.64-1.54) [640].

An updated meta-analysis of 29 RCTs with 4,127 patients found no evidence that the use of periprostatic injection of local anaesthesia resulted in more infectious complications than no injection [RR (95% CIs) 1.08 (0.80-1.49)] [640, 641, 657, 658]. An updated meta-analysis of 10 RCTs including 2,342 patients found that extended biopsy templates showed comparable infectious complications to standard templates [RR (95% CIs) 0.82 (0.55-1.24)] [640, 659]. Additional meta-analyses found no difference in infection complications relating to needle guide type (disposable vs. reusable), needle type (coaxial vs. noncoaxial), needle size (large vs. small), and number of injections for periprostatic nerve block (standard vs. extended) [640].

A meta-analysis of eleven studies with 1,753 patients showed significantly reduced infections after transrectal prostate biopsy when using antimicrobial prophylaxis as compared to placebo/control [RR (95% CI) 0.56 (0.40-0.77)] [660].

Fluoroquinolones have traditionally been used for antibiotic prophylaxis in this setting, however, overuse and misuse of fluoroquinolones have resulted in an increase in fluoroquinolone resistance. In addition, the European Commission has implemented stringent regulatory conditions regarding the use of fluoroquinolones, resulting in the suspension of the indication for perioperative antibiotic prophylaxis, including prostate biopsy [154].

A systematic review and meta-analysis on antibiotic prophylaxis for the prevention of infectious complications following prostate biopsy concluded that, in countries in which fluoroquinolones are permitted as antibiotic prophylaxis, a minimum of a full one-day administration is recommended [660]. An updated meta-analysis of ten RCTs with 3,469 patients confirmed that targeted therapy (antibiotic guidance based on rectal swab microbiology) in case of fluoroquinolone resistance is associated with reduced infectious complications [RR (95% CI) 0.54 (0.41-0.71)] [660-662]. In addition, an updated meta-analysis of ten RCTs with 2,787 patients comparing augmented prophylaxis (a combination of two or more different classes of antibiotics) to standard prophylaxis showed augmented prophylaxis to be superior [RR (95% CI) 0.44 (0.32-0.59)] [660, 663]. In countries

in which the use of fluoroquinolones has been suspended, cephalosporins or aminoglycosides can be used as individual agents with comparable infectious complications based on meta-analysis of two RCTs [660]. An updated meta-analysis of four RCTs compared fosfomycin trometamol to fluoroquinolones [RR (95% CI) 0.62 (0.37-1.06)] [660, 664]. Although initial RCTs suggested fosfomycin trometamol to be superior the latest Swedish study, which aimed to recruit 3,448 patients, was discontinued after 42 patients due to the unusually high number of hospitalisations in the fosfomycin trometamol group [664]. Another RCT showed that two doses of fosfomycin trometamol (second dose after 48 hours) were not superior to a single dose [665]. Therefore, routine general use should be critically assessed due to the relevant infectious complications also reported in non-randomised studies [666]. Of note, the indication of fosfomycin trometamol for prostate biopsy has been withdrawn in Germany, because the manufacturers did not submit the necessary pharmacokinetic data in support of this indication. Urologists are advised checking their local guidance in relation to the use of fosfomycin trometamol for prostate biopsy. Another possibility is the use of augmented prophylaxis without fluoroquinolones, although no standard combination has been established to date. Finally, targeted prophylaxis based on rectal swap/stool culture is plausible, but no RCTs are available on non-fluoroquinolones. See Figure 4 for the prostate biopsy workflow to reduce infections complications.

3.18.3 Summary of evidence and recommendations for peri-procedural antibiotic prophylaxis

Summary of evidence	**LE**
The outcome of clinical UTI was reported in four out of eleven RCTs with no benefit found for antibiotic prophylaxis versus placebo in patients following filling and voiding cystometry.	1b
A meta-analysis of five trials of moderate quality showed a benefit of using antibiotic prophylaxis for the reduction of symptomatic UTI in patients undergoing cystoscopy. However, this benefit was not seen if only the two trials with low risk of bias were used in the meta-analysis.	1a
An RCT found only small, mostly non-significant reductions in postoperative infections with a modest absolute decrease in pyelonephritis, when using antibiotic prophylaxis for ESWL. The clinical relevance of which is limited by current EU fluoroquinolone restrictions.	1a
Two meta-analyses found no evidence of benefit for antibiotic prophylaxis prior to ureteroscopy in reducing the rate of clinical UTI; however, the rate of bacteriuria was reduced.	1a
A meta-analysis of five RCTs demonstrated a moderate level of evidence that antibiotic prophylaxis was associated with a statistically significant reduction in the risk of post-procedural UTI following PNL.	1a
Two RCTs concluded that a single dose of a suitable agent was adequate for prophylaxis against clinical infection after PNL.	1b
A systematic review of 39 RCTs concluded that antibiotic prophylaxis reduced the rate of infectious complications in men undergoing TURP.	1b
A systematic review of two RCTs found no benefit for antibiotic prophylaxis in patients undergoing TURB.	1b
A meta-analysis of ten RCTs involving 4,188 patients demonstrated significantly lower rates of infectious complications, including hospital admissions and UTIs, after transperineal biopsy compared with transrectal biopsy.	1a
A meta-analysis of 23 studies (including two RCTs) with 12,324 patients reported comparable rates of post-biopsy infections in patients undergoing transperineal biopsy, irrespective of whether or not antibiotic prophylaxis was given.	2
A meta-analysis of twelve RCTs including 2,437 men showed that the use of a rectal povidone-iodine preparation before transrectal biopsy, in addition to antimicrobial prophylaxis, resulted in a significantly lower rate of infectious complications.	1a
An updated meta-analysis of ten RCTs with 3,469 patients confirmed that targeted prophylaxis (antibiotic guidance based on rectal swab microbiology) in case of fluoroquin-olone resistance is associated with reduced infectious complications.	1a
A meta-analysis of ten RCTs with 2,787 patients comparing augmented prophylaxis (combination of two or more different classes of antibiotics) to standard prophylaxis showed augmented prophylaxis to be superior.	1a

Recommendations	Strength rating
Do not use antibiotic prophylaxis to reduce the rate of symptomatic urinary infection following: • urodynamics; • cystoscopy.	Strong
Do not use antibiotic prophylaxis for extracorporeal shockwave lithotripsy in patients with sterile urine. Prescribe antibiotic prophylaxis only in the case of suspected or diagnosed infected stones or bacteriuria.	Strong
Use antibiotic prophylaxis to reduce the rate of symptomatic urinary infection following ureteroscopy.	Weak
Use single-dose antibiotic prophylaxis to reduce the rate of clinical urinary infection following percutaneous nephrolithotomy.	Strong
Use antibiotic prophylaxis to reduce infectious complications in men undergoing transurethral resection of the prostate.	Strong
Use antibiotic prophylaxis to reduce infectious complications in high-risk patients undergoing transurethral resection of the bladder.	Weak
Perform prostate biopsy using the transperineal approach due to the lower risk of infectious complications and better antibiotic stewardship.	Strong
Omit perioperative antibiotic prophylaxis in transperineal biopsy in patients without risk factors for infectious complications.	Weak
Use rectal cleansing with povidone-iodine in men prior to transrectal prostate biopsy.	Strong
Do not use fluoroquinolones for prostate biopsy. This recommendation is in line with the European Commission final decision on EMEA/H/A-31/1452.	Strong
For antibiotic prophylaxis in transrectal biopsy*, and from an antimicrobial-stewardship perspective, the following options are recommended**: • First option: Targeted prophylaxis based on rectal swab or stool culture. • Second option: Augmented prophylaxis (using two or more different classes of antibiotics.	Strong

**The indication of fosfomycin trometamol for prostate biopsy has been withdrawn in Germany, as the manufacturers did not submit the necessary pharmacokinetic data in support of this indication. Urologists are advised to check their local guidance in relation to the use of fosfomycin trometamol for prostate biopsy.*
***While most studies have been performed using fluoroquinolones, the applicability of these findings to non-fluoroquinolone antibiotics remains unclear.*

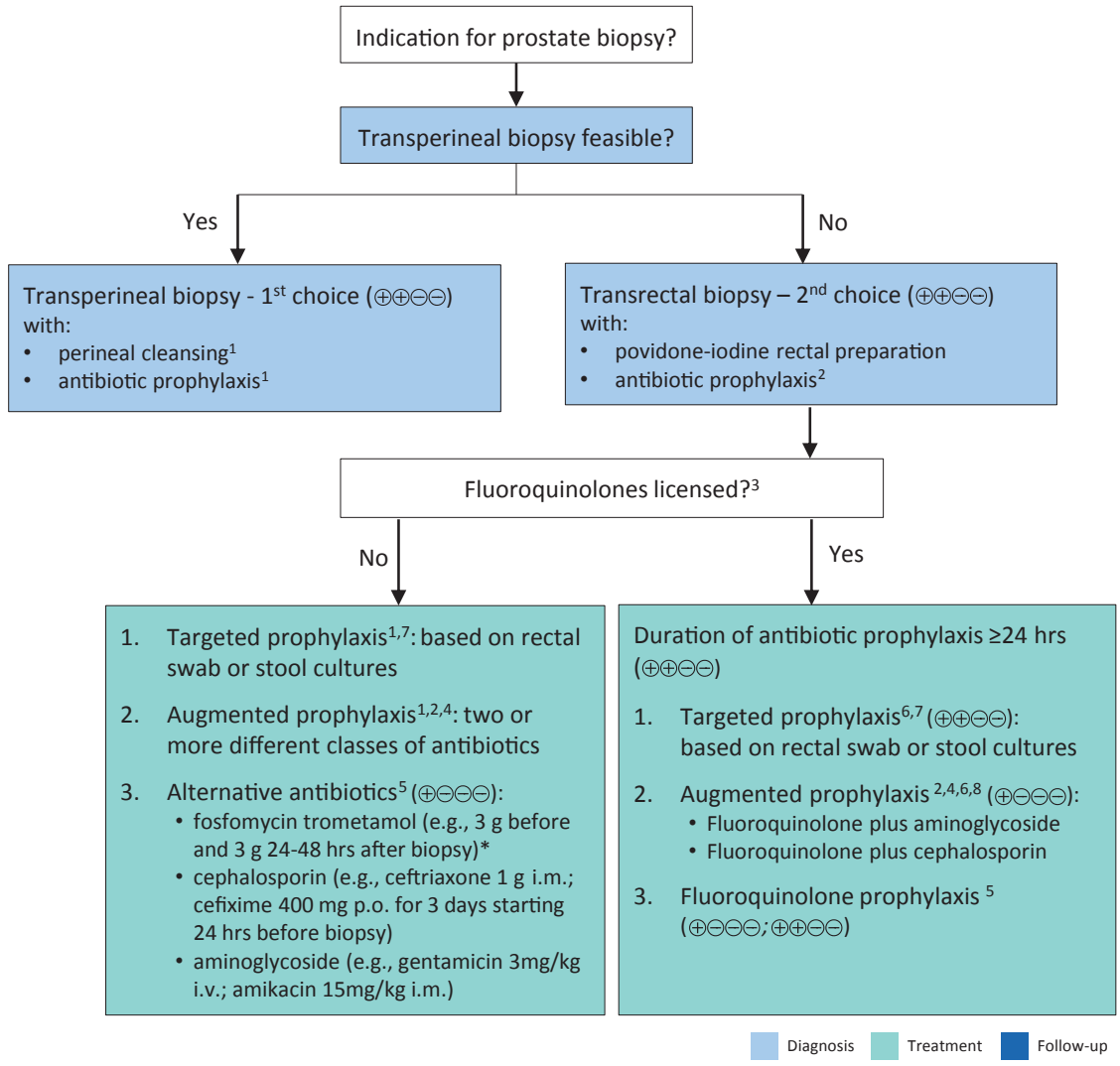
Table 15: Suggested regimens for antimicrobial prophylaxis prior to urological procedures
As stated in Section 3.18.1.d, the panel has decided not to make recommendations for specific agents for particular procedures; the agents listed below represent possible choices only. Urologists should choose a specific antimicrobial based on their knowledge of local pathogen prevalence for each type of procedure, their antibiotic susceptibility profiles and virulence.

Procedure	Prophylaxis recommended	Antimicrobial
Urodynamics	No	N/A
Cystoscopy	No	
Extracorporeal shock-wave lithotripsy	No	
Ureteroscopy	Yes	Trimethoprim Trimethoprim-sulfamethoxazole Cephalosporin group 2 or 3 Aminopenicillin plus a beta-lactamase inhibitor
Percutaneous nephro-lithotomy	Yes (single dose)	
Transurethral resec-tion of the prostate	Yes	
Transurethral resec-tion of the bladder	Yes, in patients who have a high risk of suffering postopera-tive sepsis.	

Transrectal prostate biopsy	Yes	1. Targeted prophylaxis - based on rectal swab or stool culture. 2. Augmented prophylaxis - two or more different classes of antibiotics*. 3. Alternative antibiotics • fosfomycin trometamol** (e.g. 3g before biopsy) • cephalosporin (e.g. ceftriaxone 1g i.m; cefixime 400mg p.o for three days starting 24 hours before biopsy) • aminoglycoside (e.g. gentamicin 6-7mg/kg IV q.d; amikacin 25-30 mg/kg IV q.d.)

i.m.=intramuscular; IV = intravenous; p.o.=orally; q.d = every day.
** Note: option 2 contradicts antibiotic stewardship programmes*
*** The indication of fosfomycin trometamol for prostate biopsy has been withdrawn in Germany, as the manufacturers did not submit the necessary pharmacokinetic data in support of this indication. Urologists are advised to check their local guidance in relation to the use of fosfomycin trometamol for prostate biopsy.*

Figure 4: Prostate biopsy workflow to reduce infectious complications



1. *Two systematic reviews, including non-RCTs and two RCTs, describe comparable rates of post-biopsy infection in patients with and without antibiotic prophylaxis.*
2. *Be informed about local antimicrobial resistance.*
3. *Banned by European Commission due to side effects.*
4. *Contradicts principles of antimicrobial stewardship.*
5. *Fosfomycin trometamol (4 RCTs), cephalosporins (2 RCTs), aminoglycosides (2 RCTs).*

6. *Only one RCT comparing targeted and augmented prophylaxis.*
7. *Originally introduced to use alternative antibiotics in case of fluoroquinolone resistance.*
8. *Various schemes: fluoroquinolone plus aminoglycoside (4 RCTs), and fluoroquinolone plus cephalosporin (1 RCT).*

Levels of evidence:

- *High certainty: (⊕⊕⊕⊕) Very confident that the true effect lies close to that of the estimate of the effect.*
- *Moderate certainty: (⊕⊕⊕⊖) Moderately confident in the effect estimate. The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.*
- *Low certainty: (⊕⊕⊖⊖) Confidence in the effect estimate is limited. The true effect may be substantially different from the estimate of the effect.*
- *Very low certainty: (⊕⊖⊖⊖) Very little confidence in the effect estimate. The true effect is likely to be substantially different from the estimate of effect.*

Figure reproduced from Pilatz et al. [667] with permission from Elsevier.
** The indication of fosfomycin trometamol for prostate biopsy has been withdrawn in Germany, as the manufacturers did not submit the necessary pharmacokinetic data in support of this indication. Urologists are advised to check their local guidance in relation to the use of fosfomycin trometamol for prostate biopsy.*

4. REFERENCES

1. Radmayr, C., *et al.* EAU Guidelines on Paediatric Urology, in EAU Guidelines, Edn. presented at the 41st EAU Annual Congress London. 2026. https://uroweb.org/guidelines/paediatric-urology
2. Blok, B., *et al.* EAU Guidelines on Neuro-urology, in EAU Guidelines, Edn. presented at the 41st EAU Annual Congress London. 2026. https://uroweb.org/guideline/neuro-urology/
3. Phillips B, *et al.* Oxford Centre for Evidence-based Medicine Levels of Evidence. Updated by Jeremy Howick March 2009. 1998. https://www.cebm.net/2009/06/oxford-centre-evidence-based-medicine-levels-evidence-march-2009/
4. Guyatt, G.H., *et al.* Going from evidence to recommendations. BMJ, 2008. 336: 1049. https://www.ncbi.nlm.nih.gov/pubmed/18467413
5. Horan, T.C., *et al.* CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. Am J Infect Control, 2008. 36: 309. https://www.ncbi.nlm.nih.gov/pubmed/18538699
6. Rubin, R.H., *et al.* Evaluation of new anti-infective drugs for the treatment of urinary tract infection. Infectious Diseases Society of America and the Food and Drug Administration. Clin Infect Dis, 1992. 15 Suppl 1: S216. https://www.ncbi.nlm.nih.gov/pubmed/1477233
7. Rubin, R.H., *et al.* General guidelines for the evaluation of new anti-infective drugs for the treatment of urinary tract infection. The European Society of Clinical Microbiology and Infectious diseases. Taukirchen, Germany., 1993: 240.
8. U.S. Department of Health and Human Services. FDA Center for Drug Evaluation and Research Guidance for Industry Uncomplicated Urinary Tract Infections - Developing Antimicrobial Drugs for Treatment. 2015. https://www.fda.gov/media/129531/download
9. U.S. Department of Health and Human Services. FDA Center for Drug Evaluation and Research Complicated Urinary Tract Infections: Developing Drugs for Treatment Guidance for Industry 2018. https://www.fda.gov/media/71313/download
10. Bell, B.G., *et al.* A systematic review and meta-analysis of the effects of antibiotic consumption on antibiotic resistance. BMC Infect Dis, 2014. 14: 13. https://www.ncbi.nlm.nih.gov/pubmed/24405683
11. World Health Organization. Antimicrobial resistance: global report on surveillance 2014. 2014. https://www.who.int/publications/i/item/9789241564748
12. Hulscher, M.E., *et al.* Antibiotic prescribing in hospitals: a social and behavioural scientific approach. Lancet Infect Dis, 2010. 10: 167. https://www.ncbi.nlm.nih.gov/pubmed/20185095

13. Goff, D.A., *et al.* A global call from five countries to collaborate in antibiotic stewardship: united we succeed, divided we might fail. Lancet Infect Dis, 2017. 17: e56.
https://www.ncbi.nlm.nih.gov/pubmed/27866945
14. Dellit, T.H., *et al.* Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. Clin Infect Dis, 2007. 44: 159.
https://www.ncbi.nlm.nih.gov/pubmed/17173212
15. Davey, P., *et al.* Interventions to improve antibiotic prescribing practices for hospital inpatients. Cochrane Database Syst Rev, 2017. 2: CD003543.
https://www.ncbi.nlm.nih.gov/pubmed/28178770
16. Cefai, C., *et al.* Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use. NICE Guidelines, 2015.
https://www.nice.org.uk/guidance/ng15
17. Schuts, E.C., *et al.* Current evidence on hospital antimicrobial stewardship objectives: a systematic review and meta-analysis. Lancet Infect Dis, 2016. 16: 847.
https://www.ncbi.nlm.nih.gov/pubmed/26947617
18. Hermanides, H.S., *et al.* Development of quality indicators for the antibiotic treatment of complicated urinary tract infections: a first step to measure and improve care. Clin Infect Dis, 2008. 46: 703.
https://www.ncbi.nlm.nih.gov/pubmed/18230045
19. Spoorenberg, V., *et al.* Appropriate antibiotic use for patients with urinary tract infections reduces length of hospital stay. Clin Infect Dis, 2014. 58: 164.
https://www.ncbi.nlm.nih.gov/pubmed/24158412
20. Lutay, N., *et al.* Bacterial control of host gene expression through RNA polymerase II. J Clin Invest, 2013. 123: 2366.
https://www.ncbi.nlm.nih.gov/pubmed/23728172
21. Hansson, S., *et al.* Untreated asymptomatic bacteriuria in girls: II--Effect of phenoxymethylpenicillin and erythromycin given for intercurrent infections. BMJ, 1989. 298: 856.
https://www.ncbi.nlm.nih.gov/pubmed/2497823
22. Cai, T., *et al.* The role of asymptomatic bacteriuria in young women with recurrent urinary tract infections: to treat or not to treat? Clin Infect Dis, 2012. 55: 771.
https://www.ncbi.nlm.nih.gov/pubmed/22677710
23. Nicolle, L.E., *et al.* Infectious Diseases Society of America guidelines for the diagnosis and treatment of asymptomatic bacteriuria in adults. Clin Infect Dis, 2005. 40: 643.
https://www.ncbi.nlm.nih.gov/pubmed/15714408
24. Kass, E.H. Asymptomatic infections of the urinary tract. Trans Assoc Am Physicians, 1956. 69: 56.
https://www.ncbi.nlm.nih.gov/pubmed/13380946
25. Gleckman, R., *et al.* Reliability of a single urine culture in establishing diagnosis of asymptomatic bacteriuria in adult males. J Clin Microbiol, 1979. 9: 596.
https://www.ncbi.nlm.nih.gov/pubmed/383746
26. Kunin CM. Urinary tract infections: detection, prevention and management 5th ed. Baltimore: Williams and Wilkins, 1997.
https://link.springer.com/article/10.1007/BF02771849
27. Warren, J.W., *et al.* A prospective microbiologic study of bacteriuria in patients with chronic indwelling urethral catheters. J Infect Dis, 1982. 146: 719.
https://www.ncbi.nlm.nih.gov/pubmed/6815281
28. Hooton, T.M., *et al.* Diagnosis, prevention, and treatment of catheter-associated urinary tract infection in adults: 2009 International Clinical Practice Guidelines from the Infectious Diseases Society of America. Clin Infect Dis, 2010. 50: 625.
https://www.ncbi.nlm.nih.gov/pubmed/20175247
29. Koves, B., *et al.* Benefits and Harms of Treatment of Asymptomatic Bacteriuria: A Systematic Review and Meta-analysis by the European Association of Urology Urological Infection Guidelines Panel. Eur Urol, 2017. 72: 865.
https://www.ncbi.nlm.nih.gov/pubmed/28754533
30. Tencer, J. Asymptomatic bacteriuria--a long-term study. Scand J Urol Nephrol, 1988. 22: 31.
https://www.ncbi.nlm.nih.gov/pubmed/3387908
31. Asscher, A.W., *et al.* The clinical significance of asymptomatic bacteriuria in the nonpregnant woman. J Infect Dis, 1969. 120: 17.
https://www.ncbi.nlm.nih.gov/pubmed/5803281
32. Elder, H.A., *et al.* The natural history of asymptomatic bacteriuria during pregnancy: the effect of tetracycline on the clinical course and the outcome of pregnancy. Am J Obstet Gynecol, 1971. 111: 441.
https://www.ncbi.nlm.nih.gov/pubmed/4937729

33. Elder, H.A., *et al.* Use of sulfasymazine in the treatment of bacteriuria of pregnancy. Antimicrob Agents Chemother (Bethesda), 1966. 6: 142.
https://www.ncbi.nlm.nih.gov/pubmed/4862162
34. Gold, E.M., *et al.* Asymptomatic bacteriuria during pregnancy. Obstet Gynecol, 1966. 27: 206.
https://www.ncbi.nlm.nih.gov/pubmed/5325600
35. Kass, E.H. Pyelonephritis and bacteriuria. A major problem in preventive medicine. Ann Intern Med, 1962. 56: 46.
https://www.ncbi.nlm.nih.gov/pubmed/14454174
36. Kincaid-Smith, P., *et al.* Bacteriuria in Pregnancy. Lancet, 1965. 1: 395.
https://www.ncbi.nlm.nih.gov/pubmed/14238090
37. Little, P.J. The incidence of urinary infection in 5000 pregnant women. Lancet, 1966. 2: 925.
https://www.ncbi.nlm.nih.gov/pubmed/4162367
38. Mulla, N. Bacteriuria in pregnancy. Obstet Gynecol, 1960. 16: 89.
https://www.ncbi.nlm.nih.gov/pubmed/14425118
39. Pathak, U.N., *et al.* Bacteriuria of pregnancy: results of treatment. J Infect Dis, 1969. 120: 91.
https://www.ncbi.nlm.nih.gov/pubmed/5816817
40. Robertson, J.G., *et al.* The managment and complications of asymptomatic bacteriuria in pregnancy. Report of a study on 8,275 patients. J Obstet Gynaecol Br Commonw, 1968. 75: 59.
https://www.ncbi.nlm.nih.gov/pubmed/5635245
41. Thomsen, A.C., *et al.* Antibiotic elimination of group-B streptococci in urine in prevention of preterm labour. Lancet, 1987. 1: 591.
https://www.ncbi.nlm.nih.gov/pubmed/2881132
42. Williams, G.L., *et al.* Urinary concentrating ability in women with asymptomatic bacteriuria in pregnancy. Br Med J, 1969. 3: 212.
https://www.ncbi.nlm.nih.gov/pubmed/5792611
43. Wren, B.G. Subclinical renal infection and prematurity. Med J Aust, 1969. 2: 596.
https://www.ncbi.nlm.nih.gov/pubmed/5388374
44. Kazemier, B.M., *et al.* Maternal and neonatal consequences of treated and untreated asymptomatic bacteriuria in pregnancy: a prospective cohort study with an embedded randomised controlled trial. Lancet Infect Dis, 2015. 15: 1324.
https://www.ncbi.nlm.nih.gov/pubmed/26255208
45. Henderson, J.T., *et al.* Screening for Asymptomatic Bacteriuria in Adults: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. JAMA, 2019. 322: 1195.
https://www.ncbi.nlm.nih.gov/pubmed/31550037
46. Smaill, F.M., *et al.* Antibiotics for asymptomatic bacteriuria in pregnancy. Cochrane Database Syst Rev, 2019. 2019: CD000490.
https://www.ncbi.nlm.nih.gov/pubmed/31765489
47. Wingert, A., *et al.* Asymptomatic bacteriuria in pregnancy: systematic reviews of screening and treatment effectiveness and patient preferences. BMJ Open, 2019. 9: e021347.
https://www.ncbi.nlm.nih.gov/pubmed/30872538
48. Christopher, L.J., *et al.* A trial of hippramine in the treatment of bacteriuria of pregnancy. Ir J Med Sci, 1969. 8: 331.
https://www.ncbi.nlm.nih.gov/pubmed/5806178
49. Reeves, D.S. Laboratory and clinical studies with sulfametopyrazine as a treatment for bacteriuria in pregnancy. J Antimicrob Chemother, 1975. 1: 171.
https://www.ncbi.nlm.nih.gov/pubmed/1100589
50. Whalley, P.J., *et al.* Short-term versus continuous antimicrobial therapy for asymptomatic bacteriuria in pregnancy. Obstet Gynecol, 1977. 49: 262.
https://www.ncbi.nlm.nih.gov/pubmed/320525
51. Bint, A., *et al.* A comparative trial of pivmecillinam and ampicillin in bacteriuria of pregnancy. Infection, 1979. 7: 290.
https://www.ncbi.nlm.nih.gov/pubmed/232697
52. Harris, R.E., *et al.* Single-dose antimicrobial therapy for asymptomatic bacteriuria during pregnancy. Obstet Gynecol, 1982. 59: 546.
https://www.ncbi.nlm.nih.gov/pubmed/7070725
53. Bailey, R.R., *et al.* Comparison of single dose with a 5-day course of co-trimoxazole for asymptomatic (covert) bacteriuria of pregnancy. Aust N Z J Obstet Gynaecol, 1983. 23: 139.
https://www.ncbi.nlm.nih.gov/pubmed/6606421
54. Masterton, R.G., *et al.* Single-dose amoxycillin in the treatment of bacteriuria in pregnancy and the puerperium--a controlled clinical trial. Br J Obstet Gynaecol, 1985. 92: 498.
https://www.ncbi.nlm.nih.gov/pubmed/3888250

55. Pedler, S.J., *et al.* Comparative study of amoxicillin-clavulanic acid and cephalexin in the treatment of bacteriuria during pregnancy. Antimicrob Agents Chemother, 1985. 27: 508.
https://www.ncbi.nlm.nih.gov/pubmed/4004191
56. Campbell-Brown, M., *et al.* Is screening for bacteriuria in pregnancy worth while? Br Med J (Clin Res Ed), 1987. 294: 1579.
https://www.ncbi.nlm.nih.gov/pubmed/3113538
57. Pregazzi, R., *et al.* [Single-dose antibiotic therapy of asymptomatic bacteriuria in pregnancy. Results and complications]. Minerva Ginecol, 1987. 39: 289.
https://www.ncbi.nlm.nih.gov/pubmed/3601207
58. Gerstner, G.J., *et al.* Amoxicillin in the treatment of asymptomatic bacteriuria in pregnancy: a single dose of 3 g amoxicillin versus a 4-day course of 3 doses 750 mg amoxicillin. Gynecol Obstet Invest, 1989. 27: 84.
https://www.ncbi.nlm.nih.gov/pubmed/2659442
59. Olsen, L., *et al.* Single-dose versus six-day therapy with sulfamethizole for asymptomatic bacteriuria during pregnancy. A prospective randomised study. Dan Med Bull, 1989. 36: 486.
https://www.ncbi.nlm.nih.gov/pubmed/2680315
60. Thoumsin, H., *et al.* Single dose fosfomycin trometamol versus multiple dose nitrofurantoin in pregnant women with bacteriuria: preliminary results. Infection, 1990. 18 Suppl 2: S94.
https://www.ncbi.nlm.nih.gov/pubmed/2286469
61. Bayrak, O., *et al.* Is single-dose fosfomycin trometamol a good alternative for asymptomatic bacteriuria in the second trimesterof pregnancy? Int Urogynecol J Pelvic Floor Dysfunct, 2007. 18: 525.
https://www.ncbi.nlm.nih.gov/pubmed/16941068
62. Estebanez, A., *et al.* Fosfomycin in a single dose versus a 7-day course of amoxicillin-clavulanate for the treatment of asymptomatic bacteriuria during pregnancy. Eur J Clin Microbiol Infect Dis, 2009. 28: 1457.
https://www.ncbi.nlm.nih.gov/pubmed/19768649
63. Lumbiganon, P., *et al.* One-day compared with 7-day nitrofurantoin for asymptomatic bacteriuria in pregnancy: a randomized controlled trial. Obstet Gynecol, 2009. 113: 339.
https://www.ncbi.nlm.nih.gov/pubmed/19155904
64. Widmer, M., *et al.* Duration of treatment for asymptomatic bacteriuria during pregnancy. Cochrane Database Syst Rev, 2015. 2015: CD000491.
https://www.ncbi.nlm.nih.gov/pubmed/26560337
65. Wang, T., *et al.* Comparison of single-dose fosfomycin tromethamine and other antibiotics for lower uncomplicated urinary tract infection in women and asymptomatic bacteriuria in pregnant women: A systematic review and meta-analysis. Int J Antimicrob Agents, 2020. 56: 106018.
https://www.ncbi.nlm.nih.gov/pubmed/32417205
66. Zhanel, G.G., *et al.* Asymptomatic bacteriuria in patients with diabetes mellitus. Rev Infect Dis, 1991. 13: 150.
https://www.ncbi.nlm.nih.gov/pubmed/2017615
67. Harding, G.K., *et al.* Antimicrobial treatment in diabetic women with asymptomatic bacteriuria. N Engl J Med, 2002. 347: 1576.
https://www.ncbi.nlm.nih.gov/pubmed/12432044
68. Mody, L., *et al.* Urinary tract infections in older women: a clinical review. JAMA, 2014. 311: 844.
https://www.ncbi.nlm.nih.gov/pubmed/24570248
69. Boscia, J.A., *et al.* Therapy vs no therapy for bacteriuria in elderly ambulatory nonhospitalized women. JAMA, 1987. 257: 1067.
https://www.ncbi.nlm.nih.gov/pubmed/3806896
70. Abrutyn, E., *et al.* Does asymptomatic bacteriuria predict mortality and does antimicrobial treatment reduce mortality in elderly ambulatory women? Ann Intern Med, 1994. 120: 827.
https://www.ncbi.nlm.nih.gov/pubmed/7818631
71. Abrutyn, E., *et al.* Does treatment of asymptomatic bacteriuria in older ambulatory women reduce subsequent symptoms of urinary tract infection? J Am Geriatr Soc, 1996. 44: 293.
https://www.ncbi.nlm.nih.gov/pubmed/8600199
72. Nicolle, L.E., *et al.* Prospective randomized comparison of therapy and no therapy for asymptomatic bacteriuria in institutionalized elderly women. Am J Med, 1987. 83: 27.
https://www.ncbi.nlm.nih.gov/pubmed/3300325
73. Nicolle, L.E. Asymptomatic bacteriuria in the elderly. Infect Dis Clin North Am, 1997. 11: 647.
https://www.ncbi.nlm.nih.gov/pubmed/9378928
74. Silver, S.A., *et al.* Positive urine cultures: A major cause of inappropriate antimicrobial use in hospitals? Can J Infect Dis Med Microbiol, 2009. 20: 107.
https://www.ncbi.nlm.nih.gov/pubmed/21119801

75. Trautner, B.W. Asymptomatic bacteriuria: when the treatment is worse than the disease. Nat Rev Urol, 2011. 9: 85. https://www.ncbi.nlm.nih.gov/pubmed/22143416
76. Nicolle, L.E., *et al.* Bacteriuria in elderly institutionalized men. N Engl J Med, 1983. 309: 1420. https://www.ncbi.nlm.nih.gov/pubmed/6633618
77. Potts, L., *et al.* A double-blind comparative study of norfloxacin versus placebo in hospitalised elderly patients with asymptomatic bacteriuria. Arch Gerontol Geriatr, 1996. 23: 153. https://www.ncbi.nlm.nih.gov/pubmed/15374159
78. Renneberg, J., *et al.* Single-day treatment with trimethoprim for asymptomatic bacteriuria in the elderly patient. J Urol, 1984. 132: 934. https://www.ncbi.nlm.nih.gov/pubmed/6387184
79. Ouslander, J.G., *et al.* Does eradicating bacteriuria affect the severity of chronic urinary incontinence in nursing home residents? Ann Intern Med, 1995. 122: 749. https://www.ncbi.nlm.nih.gov/pubmed/7717597
80. Krzyzaniak, N., *et al.* Antibiotics versus no treatment for asymptomatic bacteriuria in residents of aged care facilities: a systematic review and meta-analysis. Br J Gen Pract, 2022. 72: e649. https://www.ncbi.nlm.nih.gov/pubmed/35940886
81. Moradi, M., *et al.* Effect of antibiotic therapy on asymptomatic bacteriuria in kidney transplant recipients. Urol J, 2005. 2: 32. https://www.ncbi.nlm.nih.gov/pubmed/17629893
82. El Amari, E.B., *et al.* Outcome of treated and untreated asymptomatic bacteriuria in renal transplant recipients. Nephrol Dial Transplant, 2011. 26: 4109. https://www.ncbi.nlm.nih.gov/pubmed/21592976
83. Green, H., *et al.* Consequences of treated versus untreated asymptomatic bacteriuria in the first year following kidney transplantation: retrospective observational study. Eur J Clin Microbiol Infect Dis, 2013. 32: 127. https://www.ncbi.nlm.nih.gov/pubmed/22918514
84. Origuen, J., *et al.* Should Asymptomatic Bacteriuria Be Systematically Treated in Kidney Transplant Recipients? Results From a Randomized Controlled Trial. Am J Transplant, 2016. 16: 2943. https://www.ncbi.nlm.nih.gov/pubmed/27088545
85. Antonio, M.E.E., *et al.* Treatment of asymptomatic bacteriuria in the first 2 months after kidney transplant: A controlled clinical trial. Transpl Infect Dis, 2022. 24: e13934. https://www.ncbi.nlm.nih.gov/pubmed/35980169
86. Sabe, N., *et al.* Antibiotic Treatment Versus No Treatment for Asymptomatic Bacteriuria in Kidney Transplant Recipients: A Multicenter Randomized Trial. Open Forum Infect Dis, 2019. 6: ofz243. https://www.ncbi.nlm.nih.gov/pubmed/31214630
87. Arencibia, N., *et al.* Short-Term Outcome of Untreated Versus Treated Asymptomatic Bacteriuria in Renal Transplant Patients. Transplant Proc, 2016. 48: 2941. https://www.ncbi.nlm.nih.gov/pubmed/27932112
88. Coussement, J., *et al.* Antibiotics for asymptomatic bacteriuria in kidney transplant recipients. Cochrane Database Syst Rev, 2018. 2: CD011357. https://www.ncbi.nlm.nih.gov/pubmed/29390169
89. Gomez-Ochoa, S.A., *et al.* Systematic review and meta-analysis of asymptomatic bacteriuria after renal transplantation: incidence, risk of complications, and treatment outcomes. Transpl Infect Dis, 2020. 22: e13221. https://www.ncbi.nlm.nih.gov/pubmed/31782870
90. Nicolle, L.E. Urinary tract infections in patients with spinal injuries. Curr Infect Dis Rep, 2014. 16: 390. https://www.ncbi.nlm.nih.gov/pubmed/24445675
91. Wullt, B., *et al.* Bladder, bowel and bugs--bacteriuria in patients with intestinal urinary diversion. World J Urol, 2004. 22: 186. https://www.ncbi.nlm.nih.gov/pubmed/15309491
92. Qu, L.G., *et al.* Systematic review: bacterial colonisation of conduits and neobladders-when to test, watch, and treat. World J Urol, 2020. 38: 1413. https://www.ncbi.nlm.nih.gov/pubmed/31560122
93. Darouiche, R.O., *et al.* Bacterial interference for prevention of urinary tract infection: a prospective, randomized, placebo-controlled, double-blind pilot trial. Clin Infect Dis, 2005. 41: 1531. https://www.ncbi.nlm.nih.gov/pubmed/16231269
94. Sunden, F., *et al.* Escherichia coli 83972 bacteriuria protects against recurrent lower urinary tract infections in patients with incomplete bladder emptying. J Urol, 2010. 184: 179. https://www.ncbi.nlm.nih.gov/pubmed/20483149
95. Bonkat, G., *et al.* Microbial biofilm formation and catheter-associated bacteriuria in patients with suprapubic catheterisation. World J Urol, 2013. 31: 565. https://www.ncbi.nlm.nih.gov/pubmed/22926265

96. Tenke, P., *et al.* European and Asian guidelines on management and prevention of catheter-associated urinary tract infections. Int J Antimicrob Agents, 2008. 31 Suppl 1: S68.
https://www.ncbi.nlm.nih.gov/pubmed/18006279
97. Cooper, F.P., *et al.* Policies for replacing long-term indwelling urinary catheters in adults. Cochrane Database Syst Rev, 2016. 7: CD011115.
https://www.ncbi.nlm.nih.gov/pubmed/27457774
98. Dasgupta, R., *et al.* Preoperative antibiotics before endourologic surgery: current recommendations. J Endourol, 2009. 23: 1567.
https://www.ncbi.nlm.nih.gov/pubmed/19785548
99. Grabe, M., *et al.* The effect of a short antibiotic course in transurethral prostatic resection. Scand J Urol Nephrol, 1984. 18: 37.
https://www.ncbi.nlm.nih.gov/pubmed/6202000
100. Grabe, M., *et al.* Controlled trial of a short and a prolonged course with ciprofloxacin in patients undergoing transurethral prostatic surgery. Eur J Clin Microbiol, 1987. 6: 11.
https://www.ncbi.nlm.nih.gov/pubmed/3569248
101. Cafferkey, M.T., *et al.* Antibiotics for the prevention of septicaemia in urology. J Antimicrob Chemother, 1982. 9: 471.
https://www.ncbi.nlm.nih.gov/pubmed/7107549
102. Murphy, D.M., *et al.* Bacteraemia during prostatectomy and other transurethral operations: influence of timing of antibiotic administration. J Clin Pathol, 1984. 37: 673.
https://www.ncbi.nlm.nih.gov/pubmed/6725613
103. Chong, J.T., *et al.* Pre-procedural antibiotics for endoscopic urological procedures: Initial experience in individuals with spinal cord injury and asymptomatic bacteriuria. J Spinal Cord Med, 2015. 38: 187.
https://www.ncbi.nlm.nih.gov/pubmed/24621035
104. Cordero-Ampuero, J., *et al.* Are antibiotics necessary in hip arthroplasty with asymptomatic bacteriuria? Seeding risk with/without treatment. Clin Orthop Relat Res, 2013. 471: 3822.
https://www.ncbi.nlm.nih.gov/pubmed/23430723
105. Sousa, R., *et al.* Is asymptomatic bacteriuria a risk factor for prosthetic joint infection? Clin Infect Dis, 2014. 59: 41.
https://www.ncbi.nlm.nih.gov/pubmed/24723280
106. Rodriguez-Pardo, D., *et al.* Role of asymptomatic bacteriuria on early periprosthetic joint infection after hip hemiarthroplasty. BARIFER randomized clinical trial. Eur J Clin Microbiol Infect Dis, 2021. 40: 2411.
https://www.ncbi.nlm.nih.gov/pubmed/33864153
107. Gómez-Ochoa, S.A., *et al.* Risk of Surgical Site Infection in Patients with Asymptomatic Bacteriuria or Abnormal Urinalysis before Joint Arthroplasty: Systematic Review and Meta-Analysis. Surgical Infections, 2019. 20: 159.
https://www.ncbi.nlm.nih.gov/pubmed/30688601
108. Jami, S.A., *et al.* The necessity of treating asymptomatic bacteriuria with antibiotics in the perioperative period of joint arthroplasty: a metaanalysis. Turk J Med Sci, 2021. 51: 464.
https://www.ncbi.nlm.nih.gov/pubmed/33021755
109. Sousa, R.J.G., *et al.* Is Routine Urinary Screening Indicated Prior To Elective Total Joint Arthroplasty? A Systematic Review and Meta-Analysis. J Arthroplasty, 2019. 34: 1523.
https://www.ncbi.nlm.nih.gov/pubmed/30956050
110. Wang, C., *et al.* Current evidence does not support systematic antibiotherapy prior to joint arthroplasty in patients with asymptomatic bacteriuria-a meta analysis. Int Orthop, 2018. 42: 479.
https://www.ncbi.nlm.nih.gov/pubmed/29368046
111. Gomez-Ochoa, S.A., *et al.* Lack of Benefit on Treating Asymptomatic Bacteriuria Prior to Cardiovascular Surgery: a Systematic Review and Meta-Analysis. Braz J Cardiovasc Surg, 2018. 33: 641.
https://www.ncbi.nlm.nih.gov/pubmed/30652758
112. Foxman, B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. Dis Mon, 2003. 49: 53.
https://www.ncbi.nlm.nih.gov/pubmed/12601337
113. Wagenlehner, F.M., *et al.* Uncomplicated urinary tract infections. Dtsch Arztebl Int, 2011. 108: 415.
https://www.ncbi.nlm.nih.gov/pubmed/21776311
114. Stamm, W.E., *et al.* Management of urinary tract infections in adults. N Engl J Med, 1993. 329: 1328.
https://www.ncbi.nlm.nih.gov/pubmed/8413414
115. Foxman, B., *et al.* Urinary tract infection among women aged 40 to 65: behavioral and sexual risk factors. J Clin Epidemiol, 2001. 54: 710.
https://www.ncbi.nlm.nih.gov/pubmed/11438412

116. van Buul, L.W., *et al.* The Development of a Decision Tool for the Empiric Treatment of Suspected Urinary Tract Infection in Frail Older Adults: A Delphi Consensus Procedure. J Am Med Dir Assoc, 2018. 19: 757.
https://www.ncbi.nlm.nih.gov/pubmed/29910137
117. Bent, S., *et al.* Does this woman have an acute uncomplicated urinary tract infection? JAMA, 2002. 287: 2701.
https://www.ncbi.nlm.nih.gov/pubmed/12020306
118. Bradbury, S.M. Collection of urine specimens in general practice: to clean or not to clean? J R Coll Gen Pract, 1988. 38: 363.
https://www.ncbi.nlm.nih.gov/pubmed/3256648
119. Lifshitz, E., *et al.* Outpatient urine culture: does collection technique matter? Arch Intern Med, 2000. 160: 2537.
https://www.ncbi.nlm.nih.gov/pubmed/10979067
120. Fihn, S.D. Clinical practice. Acute uncomplicated urinary tract infection in women. N Engl J Med, 2003. 349: 259.
https://www.ncbi.nlm.nih.gov/pubmed/12867610
121. Foxman, B., *et al.* Epidemiology of urinary tract infections: transmission and risk factors, incidence, and costs. Infect Dis Clin North Am, 2003. 17: 227.
https://www.ncbi.nlm.nih.gov/pubmed/12848468
122. Gbinigie, O.A., *et al.* Cranberry Extract for Symptoms of Acute, Uncomplicated Urinary Tract Infection: A Systematic Review. Antibiotics (Basel), 2020. 10.
https://www.ncbi.nlm.nih.gov/pubmed/33375566
123. Barbosa-Cesnik, C., *et al.* Cranberry juice fails to prevent recurrent urinary tract infection: results from a randomized placebo-controlled trial. Clin Infect Dis, 2011. 52: 23.
https://www.ncbi.nlm.nih.gov/pubmed/21148516
124. Little, P., *et al.* Dipsticks and diagnostic algorithms in urinary tract infection: development and validation, randomised trial, economic analysis, observational cohort and qualitative study. Health Technol Assess, 2009. 13: iii.
https://www.ncbi.nlm.nih.gov/pubmed/19364448
125. Sengupta, K., *et al.* A Randomized, Double Blind, Controlled, Dose Dependent Clinical Trial to Evaluate the Efficacy of a Proanthocyanidin Standardized Whole Cranberry (Vaccinium macrocarpon) Powder on Infections of the Urinary Tract. Current Bioactive Compounds, 2011. 7: 39.
http://www.eurekaselect.com/article/18604
126. Parazzini, F., *et al.* Systematic review of the effect of D-mannose with or without other drugs in the treatment of symptoms of urinary tract infections/cystitis (Review). Biomed Rep, 2022. 17: 69.
https://pubmed.ncbi.nlm.nih.gov/35815191
127. Rădulescu, D., *et al.* Combination of cranberry extract and D-mannose - possible enhancer of uropathogen sensitivity to antibiotics in acute therapy of urinary tract infections: Results of a pilot study. Exp Ther Med, 2020. 20: 3399.
https://www.ncbi.nlm.nih.gov/pubmed/32905041
128. Porru, D., *et al.* Oral D-mannose in recurrent urinary tract infections in women: a pilot study. Journal of Clinical Urology, 2014. 7: 208.
https://doi.org/10.1177/2051415813518332
129. Domenici, L., *et al.* D-mannose: a promising support for acute urinary tract infections in women. A pilot study. Eur Rev Med Pharmacol Sci, 2016. 20: 2920.
https://www.ncbi.nlm.nih.gov/pubmed/27424995
130. Salvatore, S., *et al.* A Randomized Controlled Trial Comparing a New D-Mannose-based Dietary Supplement to Placebo for the Treatment of Uncomplicated Escherichia coli Urinary Tract Infections. Eur Urol Focus, 2023. 9: 654.
https://www.ncbi.nlm.nih.gov/pubmed/36621376
131. Wagenlehner, F.M., *et al.* Non-Antibiotic Herbal Therapy (BNO 1045) versus Antibiotic Therapy (Fosfomycin Trometamol) for the Treatment of Acute Lower Uncomplicated Urinary Tract Infections in Women: A Double-Blind, Parallel-Group, Randomized, Multicentre, Non-Inferiority Phase III Trial. Urol Int, 2018. 101: 327.
https://www.ncbi.nlm.nih.gov/pubmed/30231252
132. Cai, T., *et al.* L-Methionine associated with Hibiscus sabdariffa and Boswellia serrata extracts are not inferior to antibiotic treatment for symptoms relief in patients affected by recurrent uncomplicated urinary tract infections: Focus on antibiotic-sparing approach. Arch Ital Urol Androl, 2018. 90: 97.
https://www.ncbi.nlm.nih.gov/pubmed/29974725
133. van Wietmarschen, H., *et al.* Effectiveness of herbal medicines to prevent and control symptoms of urinary tract infections and to reduce antibiotic use: A literature review. Integr Med Res, 2022. 11: 100892.
https://www.ncbi.nlm.nih.gov/pubmed/36345487
134. Costache, R.C., *et al.* Xyloglucan + Gelose Combination versus Placebo as Adjuvant Therapy to First-Line Antimicrobials for Uncomplicated Urinary Tract Infection in Adults. Urol Int, 2019. 102: 468.
https://www.ncbi.nlm.nih.gov/pubmed/30889607

135. Cai, T., *et al.* Xyloglucan, Hibiscus and Propolis in the Management of Uncomplicated Lower Urinary Tract Infections: A Systematic Review and Meta-Analysis. Antibiotics (Basel), 2021. 11. https://www.ncbi.nlm.nih.gov/pubmed/35052890
136. Kaußner, Y., *et al.* Reducing antibiotic use in uncomplicated urinary tract infections in adult women: a systematic review and individual participant data meta-analysis. Clin Microbiol Infect, 2022. 28: 1558. https://pubmed.ncbi.nlm.nih.gov/35788049
137. Ong Lopez, A.M.C., *et al.* Symptomatic treatment (using NSAIDS) versus antibiotics in uncomplicated lower urinary tract infection: a meta-analysis and systematic review of randomized controlled trials. BMC Infect Dis, 2021. 21: 619. https://www.ncbi.nlm.nih.gov/pubmed/34187385
138. Bleidorn, J., *et al.* Symptomatic treatment (ibuprofen) or antibiotics (ciprofloxacin) for uncomplicated urinary tract infection? - Results of a randomized controlled pilot trial. BMC Medicine, 2010. 8: 30. https://pubmed.ncbi.nlm.nih.gov/20504298/
139. Gágyor, I., *et al.* Ibuprofen versus fosfomycin for uncomplicated urinary tract infection in women: randomised controlled trial. Bmj, 2015. 351: h6544. https://pubmed.ncbi.nlm.nih.gov/26698878
140. Vik, I., *et al.* Ibuprofen versus pivmecillinam for uncomplicated urinary tract infection in women-A double-blind, randomized non-inferiority trial. PLoS Med, 2018. 15: e1002569. https://pubmed.ncbi.nlm.nih.gov/29763434
141. Kronenberg, A., *et al.* Symptomatic treatment of uncomplicated lower urinary tract infections in the ambulatory setting: randomised, double blind trial. Bmj, 2017. 359: j4784. https://pubmed.ncbi.nlm.nih.gov/29113968
142. Gágyor, I., *et al.* Herbal treatment with uva ursi extract versus fosfomycin in women with uncomplicated urinary tract infection in primary care: a randomized controlled trial. Clin Microbiol Infect, 2021. 27: 1441. https://pubmed.ncbi.nlm.nih.gov/34111592
143. Mann, N.K., *et al.* Potentially Inadequate Medications in the Elderly: PRISCUS 2.0. Dtsch Arztebl Int, 2023. 120: 3. https://pubmed.ncbi.nlm.nih.gov/36507719
144. Falagas, M.E., *et al.* Antibiotics versus placebo in the treatment of women with uncomplicated cystitis: a meta-analysis of randomized controlled trials. J Infect, 2009. 58: 91. https://www.ncbi.nlm.nih.gov/pubmed/19195714
145. e.V., D.G.f.U., S3 Leitlinie: Epidemiologie, Diagnostik, Therapie, Prävention und Management unkomplizierter, bakterieller, ambulant erworbener Harnwegsinfektionen bei Erwachsenen - Aktualisierung 2024. 2024. https://register.awmf.org/de/leitlinien/detail/043-044
146. Gupta, K., *et al.* Short-course nitrofurantoin for the treatment of acute uncomplicated cystitis in women. Arch Intern Med, 2007. 167: 2207. https://www.ncbi.nlm.nih.gov/pubmed/17998493
147. Lecomte, F., *et al.* Single-dose treatment of cystitis with fosfomycin trometamol (Monuril): analysis of 15 comparative trials on 2,048 patients. . Giorn It Ost Gin, 1997. 19: 399. https://www.sciencedirect.com/science/article/pii/S0399077X96802095
148. Nicolle, L.E. Pivmecillinam in the treatment of urinary tract infections. J Antimicrob Chemother, 2000. 46 Suppl 1: 35. https://www.ncbi.nlm.nih.gov/pubmed/11051622
149. Huttner, A., *et al.* Nitrofurantoin revisited: a systematic review and meta-analysis of controlled trials. J Antimicrob Chemother, 2015. 70: 2456. https://www.ncbi.nlm.nih.gov/pubmed/26066581
150. Gupta, K., *et al.* Outcomes associated with trimethoprim/sulphamethoxazole (TMP/SMX) therapy in TMP/SMX resistant community-acquired UTI. Int J Antimicrob Agents, 2002. 19: 554. https://www.ncbi.nlm.nih.gov/pubmed/12135847
151. Warren, J.W., *et al.* Guidelines for antimicrobial treatment of uncomplicated acute bacterial cystitis and acute pyelonephritis in women. Infectious Diseases Society of America (IDSA). Clin Infect Dis, 1999. 29: 745. https://www.ncbi.nlm.nih.gov/pubmed/10589881
152. Hooton, T.M., *et al.* Cefpodoxime vs ciprofloxacin for short-course treatment of acute uncomplicated cystitis: a randomized trial. JAMA, 2012. 307: 583. https://www.ncbi.nlm.nih.gov/pubmed/22318279
153. Hooton, T.M., *et al.* Amoxicillin-clavulanate vs ciprofloxacin for the treatment of uncomplicated cystitis in women: a randomized trial. JAMA, 2005. 293: 949. https://www.ncbi.nlm.nih.gov/pubmed/15728165

154. European Medicines Agency. Disabling and potentially permanent side effects lead to suspension or restrictions of quinolone and fluoroquinolone antibiotics. Quinolone and fluoroquinolone Article-31 referral, 2019. https://www.ema.europa.eu/en/news/disabling-potentially-permanent-side-effects-lead-suspension-or-restrictions-quinolone-fluoroquinolone-antibiotics
155. Vazquez, J.C., *et al.* Treatments for symptomatic urinary tract infections during pregnancy. Cochrane Database Syst Rev, 2000: CD002256. https://www.ncbi.nlm.nih.gov/pubmed/10908537
156. Geerts, A.F., *et al.* Ineffectiveness and adverse events of nitrofurantoin in women with urinary tract infection and renal impairment in primary care. Eur J Clin Pharmacol, 2013. 69: 1701. https://www.ncbi.nlm.nih.gov/pubmed/23660771
157. German Society of Urology. 3 guideline: epidemiology, diagnosis, treatment, prevention and management of uncomplicated, bacterial, community-acquired urinary tract infections in adults - update 2024. 2024. https://register.awmf.org/de/leitlinien/detail/043-044
158. Hooton, T.M. Recurrent urinary tract infection in women. Int J Antimicrob Agents, 2001. 17: 259. https://www.ncbi.nlm.nih.gov/pubmed/11295405
159. Naber, K.G., *et al.* Psychosocial burden of recurrent uncomplicated urinary tract infections. GMS Infect Dis, 2022. 10: Doc01. https://www.ncbi.nlm.nih.gov/pubmed/35463815
160. van Haarst, E.P., *et al.* Evaluation of the diagnostic workup in young women referred for recurrent lower urinary tract infections. Urology, 2001. 57: 1068. https://www.ncbi.nlm.nih.gov/pubmed/11377307
161. Hooton, T.M., Prevention of recurrent urogenital tract infections in adult women, in EAU/International Consultation on Urological Infections. T, K.G. Naber, A.J. Schaeffer, C.F. Hynes & e. al., Editors. 2010, European Association of Urology: The Netherlands. http://www.icud.info/urogenitalinfections.html
162. Cai, T., *et al.* Management of Recurrent Cystitis in Women: When Prompt Identification of Risk Factors Might Make a Difference. Eur Urol Focus, 2022. 8: 1476. https://www.ncbi.nlm.nih.gov/pubmed/35135727
163. Adatto, K., *et al.* Behavioral factors and urinary tract infection. JAMA, 1979. 241: 2525. https://www.ncbi.nlm.nih.gov/pubmed/439337
164. Lumsden, L., *et al.* Effects of an educational intervention on the rate of recurrent urinary tract infections in selected female outpatients. Women Health, 1985. 10: 79. https://www.ncbi.nlm.nih.gov/pubmed/3984360
165. Hooton, T.M., *et al.* Effect of Increased Daily Water Intake in Premenopausal Women With Recurrent Urinary Tract Infections: A Randomized Clinical Trial. JAMA Intern Med, 2018. 178: 1509. https://www.ncbi.nlm.nih.gov/pubmed/30285042
166. Chen, Y.Y., *et al.* Estrogen for the prevention of recurrent urinary tract infections in postmenopausal women: a meta-analysis of randomized controlled trials. Int Urogynecol J, 2021. 32: 17. https://www.ncbi.nlm.nih.gov/pubmed/32564121
167. Beerepoot, M.A., *et al.* Nonantibiotic prophylaxis for recurrent urinary tract infections: a systematic review and meta-analysis of randomized controlled trials. J Urol, 2013. 190: 1981. https://www.ncbi.nlm.nih.gov/pubmed/23867306
168. Leckie, K.J. What is the evidence for the role of oestrogen in the prevention of recurrent urinary tract infections in postmenopausal women? An evidence-based review. J Clin Gerontol Geriatr, 2010. 1: 31. https://www.sciencedirect.com/science/article/pii/S2210833510000298
169. Duenas-Garcia, O.F., *et al.* Pharmacological Agents to Decrease New Episodes of Recurrent Lower Urinary Tract Infections in Postmenopausal Women. A Systematic Review. Female Pelvic Med Reconstr Surg, 2016. 22: 63. https://www.ncbi.nlm.nih.gov/pubmed/26825411
170. Pinggera, G.M., *et al.* Effects of local estrogen therapy on recurrent urinary tract infections in young females under oral contraceptives. Eur Urol, 2005. 47: 243. https://www.ncbi.nlm.nih.gov/pubmed/15661421
171. Mak, Q., *et al.* Bacterial Vaccines for the Management of Recurrent Urinary Tract Infections: A Systematic Review and Meta-analysis. Eur Urol Focus, 2024. 10: 761. https://www.ncbi.nlm.nih.gov/pubmed/38644097
172. Kranz, J., *et al.* Current Evidence on Nonantibiotic Prevention of Recurrent Urinary Tract Infections. Eur Urol Focus, 2019. 5: 17. https://www.ncbi.nlm.nih.gov/pubmed/30292420
173. Abad, C.L., *et al.* The role of lactobacillus probiotics in the treatment or prevention of urogenital infections--a systematic review. J Chemother, 2009. 21: 243. https://www.ncbi.nlm.nih.gov/pubmed/19567343

174. Canales, J., *et al.* Are probiotics effective in preventing urinary tract infection? Medwave, 2018. 18: e7186. https://www.ncbi.nlm.nih.gov/pubmed/29624569
175. Falagas, M.E., *et al.* Probiotics for prevention of recurrent urinary tract infections in women: a review of the evidence from microbiological and clinical studies. Drugs, 2006. 66: 1253. https://www.ncbi.nlm.nih.gov/pubmed/16827601
176. Grin, P.M., *et al.* Lactobacillus for preventing recurrent urinary tract infections in women: meta-analysis. Can J Urol, 2013. 20: 6607. https://www.ncbi.nlm.nih.gov/pubmed/23433130
177. Hanson, L., *et al.* Probiotics for Treatment and Prevention of Urogenital Infections in Women: A Systematic Review. J Midwifery Womens Health, 2016. 61: 339. https://www.ncbi.nlm.nih.gov/pubmed/27218592
178. Ng, Q.X., *et al.* Use of Lactobacillus spp. to prevent recurrent urinary tract infections in females. Med Hypotheses, 2018. 114: 49. https://www.ncbi.nlm.nih.gov/pubmed/29602464
179. Akgul, T., *et al.* The role of probiotics in women with recurrent urinary tract infections. Turk J Urol, 2018. 44: 377. https://www.ncbi.nlm.nih.gov/pubmed/30487041
180. Andreu, A. Lactobacillus as a probiotic for preventing urogenital infections. Reviews in Medical Microbiology, 2004. 15: 1. https://www.researchgate.net/publication/232117977
181. Barrons, R., *et al.* Use of Lactobacillus probiotics for bacterial genitourinary infections in women: a review. Clin Ther, 2008. 30: 453. https://www.ncbi.nlm.nih.gov/pubmed/18405785
182. Hoesl, C.E., *et al.* The probiotic approach: an alternative treatment option in urology. Eur Urol, 2005. 47: 288. https://www.ncbi.nlm.nih.gov/pubmed/15716188
183. Ray, K. Infection: Lactobacillus probiotic could prevent recurrent UTI. Nat Rev Urol, 2011. 8: 292. https://www.ncbi.nlm.nih.gov/pubmed/21660070
184. Reid, G., *et al.* Probiotics to prevent urinary tract infections: the rationale and evidence. World J Urol, 2006. 24: 28. https://www.ncbi.nlm.nih.gov/pubmed/16389539
185. Abdullatif, V.A., *et al.* Efficacy of Probiotics as Prophylaxis for Urinary Tract Infections in Premenopausal Women: A Systematic Review and Meta-Analysis. Cureus, 2021. 13: e18843. https://www.ncbi.nlm.nih.gov/pubmed/34671514
186. Naber, K.G., *et al.* Therapeutic strategies for uncomplicated cystitis in women. GMS Infect Dis, 2024. 12: Doc01. https://www.ncbi.nlm.nih.gov/pubmed/38764941
187. Sabadash, M., *et al.* Canephron® N in the treatment of recurrent cystitis in women of child-bearing Age: a randomised controlled study. Clinical Phytoscience, 2017. 3: 9. https://clinphytoscience.springeropen.com/articles/10.1186/s40816-017-0046-7
188. Hudson, R.E., *et al.* Examination of Complementary Medicine for Treating Urinary Tract Infections Among Pregnant Women and Children. Front Pharmacol, 2022. 13: 883216. https://www.ncbi.nlm.nih.gov/pubmed/35571128
189. Jepson, R.G., *et al.* Cranberries for preventing urinary tract infections. Cochrane Database Syst Rev, 2012. 10: CD001321. https://www.ncbi.nlm.nih.gov/pubmed/23076891
190. Fu, Z., *et al.* Cranberry Reduces the Risk of Urinary Tract Infection Recurrence in Otherwise Healthy Women: A Systematic Review and Meta-Analysis. J Nutr, 2017. 147: 2282. https://www.ncbi.nlm.nih.gov/pubmed/29046404
191. Luis, A., *et al.* Can Cranberries Contribute to Reduce the Incidence of Urinary Tract Infections? A Systematic Review with Meta-Analysis and Trial Sequential Analysis of Clinical Trials. J Urol, 2017. 198: 614. https://www.ncbi.nlm.nih.gov/pubmed/28288837
192. Wang, C.H., *et al.* Cranberry-containing products for prevention of urinary tract infections in susceptible populations: a systematic review and meta-analysis of randomized controlled trials. Arch Intern Med, 2012. 172: 988. https://www.ncbi.nlm.nih.gov/pubmed/22777630
193. Tambunan, M.P., *et al.* Cranberries for women with recurrent urinary tract infection: a meta-analysis. Medical Journal of Indonesia, 2019. 28: 268. https://mji.ui.ac.id/journal/index.php/mji/article/view/3299
194. Xia, J.Y., *et al.* Consumption of cranberry as adjuvant therapy for urinary tract infections in susceptible populations: A systematic review and meta-analysis with trial sequential analysis. PLoS One, 2021. 16: e0256992. https://www.ncbi.nlm.nih.gov/pubmed/34473789

195. Liska, D.J., *et al.* Cranberries and Urinary Tract Infections: How Can the Same Evidence Lead to Conflicting Advice? Adv Nutr, 2016. 7: 498.
https://www.ncbi.nlm.nih.gov/pubmed/27184277
196. Babar, A., *et al.* High dose versus low dose standardized cranberry proanthocyanidin extract for the prevention of recurrent urinary tract infection in healthy women: a double-blind randomized controlled trial. BMC Urol, 2021. 21: 44.
https://www.ncbi.nlm.nih.gov/pubmed/33757474
197. Rondanelli, M., *et al.* Supplementation with Highly Standardized Cranberry Extract Phytosome Achieved the Modulation of Urinary Tract Infection Episodes in Diabetic Postmenopausal Women Taking SGLT-2 Inhibitors: A RCT Study. Nutrients, 2024. 16.
https://pubmed.ncbi.nlm.nih.gov/38999860
198. Tsiakoulias, E., *et al.* Randomized, placebo-controlled, double-blinded study of prophylactic cranberries use in women with recurrent uncomplicated cystitis. World J Urol, 2024. 42: 27.
https://pubmed.ncbi.nlm.nih.gov/38214795
199. Moro, C., *et al.* Cranberry Juice, Cranberry Tablets, or Liquid Therapies for Urinary Tract Infection: A Systematic Review and Network Meta-analysis. European Urology Focus, 2024.
https://pubmed.ncbi.nlm.nih.gov/39030132/
200. Lenger, S.M., *et al.* D-mannose vs other agents for recurrent urinary tract infection prevention in adult women: a systematic review and meta-analysis. Am J Obstet Gynecol, 2020. 223: 265 e1.
https://www.ncbi.nlm.nih.gov/pubmed/32497610
201. Kyriakides, R., *et al.* Role of D-Mannose in the Prevention of Recurrent Urinary Tract Infections: Evidence from a Systematic Review of the Literature. Eur Urol Focus, 2021. 7: 1166.
https://www.ncbi.nlm.nih.gov/pubmed/32972899
202. Cooper, T.E., *et al.* D-mannose for preventing and treating urinary tract infections. Cochrane Database Syst Rev, 2022. 8: CD013608.
https://www.ncbi.nlm.nih.gov/pubmed/36041061
203. Hayward, G., *et al.* d-Mannose for Prevention of Recurrent Urinary Tract Infection Among Women: A Randomized Clinical Trial. JAMA Internal Medicine, 2024. 184: 619.
https://doi.org/10.1001/jamainternmed.2024.0264
204. Damiano, R., *et al.* Prevention of recurrent urinary tract infections by intravesical administration of hyaluronic acid and chondroitin sulphate: a placebo-controlled randomised trial. Eur Urol, 2011. 59: 645.
https://www.ncbi.nlm.nih.gov/pubmed/21272992
205. De Vita, D., *et al.* Effectiveness of intravesical hyaluronic acid/chondroitin sulfate in recurrent bacterial cystitis: a randomized study. Int Urogynecol J, 2012. 23: 1707.
https://www.ncbi.nlm.nih.gov/pubmed/22614285
206. Goddard, J.C., *et al.* Intravesical hyaluronic acid and chondroitin sulfate for recurrent urinary tract infections: systematic review and meta-analysis. Int Urogynecol J, 2018. 29: 933.
https://www.ncbi.nlm.nih.gov/pubmed/29181550
207. Lee, B.S., *et al.* Methenamine hippurate for preventing urinary tract infections. Cochrane Database Syst Rev, 2012. 10: CD003265.
https://www.ncbi.nlm.nih.gov/pubmed/23076896
208. Bakhit, M., *et al.* Use of methenamine hippurate to prevent urinary tract infections in community adult women: a systematic review and meta-analysis. Br J Gen Pract, 2021. 71: e528.
https://www.ncbi.nlm.nih.gov/pubmed/34001538
209. Harding, C., *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: 1.
https://www.ncbi.nlm.nih.gov/pubmed/35535708
210. Harding, C., *et al.* Alternative to prophylactic antibiotics for the treatment of recurrent urinary tract infections in women: multicentre, open label, randomised, non-inferiority trial. BMJ, 2022. 376: e068229.
https://www.ncbi.nlm.nih.gov/pubmed/35264408
211. Nalliah, S., *et al.* The use of chemotherapeutic agents as prophylaxis for recurrent urinary tract infection in healthy nonpregnant women: A network meta-analysis. Indian J Urol, 2019. 35: 147.
https://www.ncbi.nlm.nih.gov/pubmed/31000921
212. Ahmed, H., *et al.* Long-term antibiotics for prevention of recurrent urinary tract infection in older adults: systematic review and meta-analysis of randomised trials. BMJ Open, 2017. 7: e015233.
https://www.ncbi.nlm.nih.gov/pubmed/28554926
213. Price, J.R., *et al.* Nitrofurantoin vs other prophylactic agents in reducing recurrent urinary tract infections in adult women: a systematic review and meta-analysis. Am J Obstet Gynecol, 2016. 215: 548.
https://www.ncbi.nlm.nih.gov/pubmed/27457111

214. Albert, X., *et al.* Antibiotics for preventing recurrent urinary tract infection in non-pregnant women. Cochrane Database Syst Rev, 2004. 2004: CD001209.
https://www.ncbi.nlm.nih.gov/pubmed/15266443
215. Eells, S.J., *et al.* Recurrent urinary tract infections among women: comparative effectiveness of 5 prevention and management strategies using a Markov chain Monte Carlo model. Clin Infect Dis, 2014. 58: 147.
https://www.ncbi.nlm.nih.gov/pubmed/24065333
216. Anger, J., *et al.* Recurrent Uncomplicated Urinary Tract Infections in Women: AUA/CUA/SUFU Guideline. J Urol, 2019. 202: 282.
https://www.ncbi.nlm.nih.gov/pubmed/31042112
217. Kranz, J., *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: 271.
https://www.ncbi.nlm.nih.gov/pubmed/29539622
218. Epp, A., *et al.* No. 250-Recurrent Urinary Tract Infection. J Obstet Gynaecol Can, 2017. 39: e422.
https://www.ncbi.nlm.nih.gov/pubmed/28935065
219. Lichtenberger, P., *et al.* Antimicrobial prophylaxis in women with recurrent urinary tract infections. Int J Antimicrob Agents, 2011. 38 Suppl: 36.
https://www.ncbi.nlm.nih.gov/pubmed/22055655
220. Sen, A. Recurrent cystitis in non-pregnant women. BMJ Clin Evid, 2008. 2008.
https://www.ncbi.nlm.nih.gov/pubmed/19445741
221. Chew, L.D., *et al.* Recurrent cystitis in nonpregnant women. West J Med, 1999. 170: 274.
https://www.ncbi.nlm.nih.gov/pubmed/10379218
222. Rudenko, N., *et al.* Prevention of recurrent lower urinary tract infections by long-term administration of fosfomycin trometamol. Double blind, randomized, parallel group, placebo controlled study. Arzneimittelforschung, 2005. 55: 420.
https://www.ncbi.nlm.nih.gov/pubmed/16080282
223. Costantini, E., *et al.* Prulifloxacin vs fosfomycin for prophylaxis in female patients with recurrent UTIs: a non-inferiority trial. Int Urogynecol J, 2014. 25: 1173.
https://pubmed.ncbi.nlm.nih.gov/24554302
224. Pfau, A., *et al.* Effective prophylaxis for recurrent urinary tract infections during pregnancy. Clin Infect Dis, 1992. 14: 810.
https://www.ncbi.nlm.nih.gov/pubmed/1576275
225. Schaeffer, A.J., *et al.* Efficacy and safety of self-start therapy in women with recurrent urinary tract infections. J Urol, 1999. 161: 207.
https://www.ncbi.nlm.nih.gov/pubmed/10037399
226. Scholes, D., *et al.* Risk factors associated with acute pyelonephritis in healthy women. Ann Intern Med, 2005. 142: 20.
https://www.ncbi.nlm.nih.gov/pubmed/15630106
227. Hill, J.B., *et al.* Acute pyelonephritis in pregnancy. Obstet Gynecol, 2005. 105: 18.
https://www.ncbi.nlm.nih.gov/pubmed/15625136
228. Fulop, T. Acute Pyelonephritis Workup. 2012.
http://emedicine.medscape.com/article/245559-workup#aw2aab6b5b3
229. van Nieuwkoop, C., *et al.* Predicting the need for radiologic imaging in adults with febrile urinary tract infection. Clin Infect Dis, 2010. 51: 1266.
https://www.ncbi.nlm.nih.gov/pubmed/21034195
230. Cattrall, J.W.S., *et al.* A systematic review of randomised clinical trials for oral antibiotic treatment of acute pyelonephritis. Eur J Clin Microbiol Infect Dis, 2018. 37: 2285.
https://www.ncbi.nlm.nih.gov/pubmed/30191339
231. Gupta, K., *et al.* International clinical practice guidelines for the treatment of acute uncomplicated cystitis and pyelonephritis in women: A 2010 update by the Infectious Diseases Society of America and the European Society for Microbiology and Infectious Diseases. Clin Infect Dis, 2011. 52: e103.
https://www.ncbi.nlm.nih.gov/pubmed/21292654
232. Berti, F., *et al.* Short versus long course antibiotic therapy for acute pyelonephritis in adults: a systematic review and meta-analysis. Italian Journal of Medicine, 2018. 12: 39.
https://www.italjmed.org/index.php/ijm/article/view/itjm.2018.840
233. Hooton, T.M. Clinical practice. Uncomplicated urinary tract infection. N Engl J Med, 2012. 366: 1028.
https://www.ncbi.nlm.nih.gov/pubmed/22417256
234. Arakawa, S., *et al.* The efficacy and safety of tazobactam/ceftolozane in Japanese patients with uncomplicated pyelonephritis and complicated urinary tract infection. J Infect Chemother, 2019. 25: 104.
https://www.ncbi.nlm.nih.gov/pubmed/30420153

235. Armstrong, E.S., *et al.* Outcomes of high-dose levofloxacin therapy remain bound to the levofloxacin minimum inhibitory concentration in complicated urinary tract infections. BMC Infect Dis, 2016. 16: 710.
https://www.ncbi.nlm.nih.gov/pubmed/27887579
236. Huntington, J.A., *et al.* Efficacy of ceftolozane/tazobactam versus levofloxacin in the treatment of complicated urinary tract infections (cUTIs) caused by levofloxacin-resistant pathogens: results from the ASPECT-cUTI trial. J Antimicrob Chemother, 2016. 71: 2014.
https://www.ncbi.nlm.nih.gov/pubmed/26994090
237. Carmeli, Y., *et al.* Ceftazidime-avibactam or best available therapy in patients with ceftazidime-resistant Enterobacteriaceae and Pseudomonas aeruginosa complicated urinary tract infections or complicated intra-abdominal infections (REPRISE): a randomised, pathogen-directed, phase 3 study. Lancet Infect Dis, 2016. 16: 661.
https://www.ncbi.nlm.nih.gov/pubmed/27107460
238. Sims, M., *et al.* Prospective, randomized, double-blind, Phase 2 dose-ranging study comparing efficacy and safety of imipenem/cilastatin plus relebactam with imipenem/cilastatin alone in patients with complicated urinary tract infections. J Antimicrob Chemother, 2017. 72: 2616.
https://www.ncbi.nlm.nih.gov/pubmed/28575389
239. Wagenlehner, F.M., *et al.* Ceftazidime-avibactam Versus Doripenem for the Treatment of Complicated Urinary Tract Infections, Including Acute Pyelonephritis: RECAPTURE, a Phase 3 Randomized Trial Program. Clin Infect Dis, 2016. 63: 754.
https://www.ncbi.nlm.nih.gov/pubmed/27313268
240. Kaye, K.S., *et al.* Effect of Meropenem-Vaborbactam vs Piperacillin-Tazobactam on Clinical Cure or Improvement and Microbial Eradication in Complicated Urinary Tract Infection: The TANGO I Randomized Clinical Trial. JAMA, 2018. 319: 788.
https://www.ncbi.nlm.nih.gov/pubmed/29486041
241. Wunderink, R.G., *et al.* Effect and Safety of Meropenem-Vaborbactam versus Best-Available Therapy in Patients with Carbapenem-Resistant Enterobacteriaceae Infections: The TANGO II Randomized Clinical Trial. Infect Dis Ther, 2018. 7: 439.
https://www.ncbi.nlm.nih.gov/pubmed/30270406
242. Wagenlehner, F.M.E., *et al.* Once-Daily Plazomicin for Complicated Urinary Tract Infections. N Engl J Med, 2019. 380: 729.
https://www.ncbi.nlm.nih.gov/pubmed/30786187
243. Portsmouth, S., *et al.* Cefiderocol versus imipenem-cilastatin for the treatment of complicated urinary tract infections caused by Gram-negative uropathogens: a phase 2, randomised, double-blind, non-inferiority trial. Lancet Infect Dis, 2018. 18: 1319.
https://www.ncbi.nlm.nih.gov/pubmed/30509675
244. Pitout, J.D. Infections with extended-spectrum beta-lactamase-producing enterobacteriaceae: changing epidemiology and drug treatment choices. Drugs, 2010. 70: 313.
https://www.ncbi.nlm.nih.gov/pubmed/20166768
245. Mombelli, G., *et al.* Oral vs intravenous ciprofloxacin in the initial empirical management of severe pyelonephritis or complicated urinary tract infections: a prospective randomized clinical trial. Arch Intern Med, 1999. 159: 53.
https://www.ncbi.nlm.nih.gov/pubmed/9892331
246. Millar, L.K., *et al.* Outpatient treatment of pyelonephritis in pregnancy: a randomized controlled trial. Obstet Gynecol, 1995. 86: 560.
https://www.ncbi.nlm.nih.gov/pubmed/7675380
247. Wing, D.A., *et al.* A randomized trial of three antibiotic regimens for the treatment of pyelonephritis in pregnancy. Obstet Gynecol, 1998. 92: 249.
https://www.ncbi.nlm.nih.gov/pubmed/9699761
248. Ulleryd, P., *et al.* Ciprofloxacin for 2 or 4 weeks in the treatment of febrile urinary tract infection in men: a randomized trial with a 1 year follow-up. Scand J Infect Dis, 2003. 35: 34.
https://www.ncbi.nlm.nih.gov/pubmed/12685882
249. Chihara, S., *et al.* Staphylococcus aureus bacteriuria as a prognosticator for outcome of Staphylococcus aureus bacteremia: a case-control study. BMC Infect Dis, 2010. 10: 225.
https://www.ncbi.nlm.nih.gov/pubmed/20667139/
250. Papadimitriou-Olivgeris, M., *et al.* Clinical significance of concomitant bacteriuria in patients with Staphylococcus aureus bacteraemia. Eur J Clin Microbiol Infect Dis, 2023. 42: 379.
https://pubmed.ncbi.nlm.nih.gov/36725816
251. Kawashima, A., *et al.* Radiologic evaluation of patients with renal infections. Infect Dis Clin North Am, 2003. 17: 433.
https://pubmed.ncbi.nlm.nih.gov/12848478

252. Zulfiqar, M., *et al.* Imaging of Renal Infections and Inflammatory Disease. Radiol Clin North Am, 2020. 58: 909. https://pubmed.ncbi.nlm.nih.gov/32792123
253. Golan, Y. Empiric therapy for hospital-acquired, Gram-negative complicated intra-abdominal infection and complicated urinary tract infections: a systematic literature review of current and emerging treatment options. BMC Infect Dis, 2015. 15: 313. https://pubmed.ncbi.nlm.nih.gov/26243291
254. Singh, K.P., *et al.* Systematic review and meta-analysis of antimicrobial treatment effect estimation in complicated urinary tract infection. Antimicrob Agents Chemother, 2013. 57: 5284. https://pubmed.ncbi.nlm.nih.gov/23939900
255. Kaye, K.S., *et al.* Fosfomycin for Injection (ZTI-01) Versus Piperacillin-tazobactam for the Treatment of Complicated Urinary Tract Infection Including Acute Pyelonephritis: ZEUS, A Phase 2/3 Randomized Trial. Clin Infect Dis, 2019. 69: 2045. https://pubmed.ncbi.nlm.nih.gov/30861061
256. Wagenlehner, F.M.E., *et al.* Once-Daily Plazomicin for Complicated Urinary Tract Infections. N Engl J Med, 2019. 380: 729. https://www.ncbi.nlm.nih.gov/pubmed/30786187
257. Popejoy, M.W., *et al.* Efficacy of ceftolozane/tazobactam against urinary tract and intra-abdominal infections caused by ESBL-producing Escherichia coli and Klebsiella pneumoniae: a pooled analysis of Phase 3 clinical trials. J Antimicrob Chemother, 2017. 72: 268. https://pubmed.ncbi.nlm.nih.gov/27707990
258. Daneman, N., *et al.* Antibiotic Treatment for 7 versus 14 Days in Patients with Bloodstream Infections. N Engl J Med, 2024. https://pubmed.ncbi.nlm.nih.gov/40601954
259. McAteer, J., *et al.* Defining the Optimal Duration of Therapy for Hospitalized Patients With Complicated Urinary Tract Infections and Associated Bacteremia. Clin Infect Dis, 2023. 76: 1604. https://pubmed.ncbi.nlm.nih.gov/36633559
260. Peterson, J., *et al.* A double-blind, randomized comparison of levofloxacin 750 mg once-daily for five days with ciprofloxacin 400/500 mg twice-daily for 10 days for the treatment of complicated urinary tract infections and acute pyelonephritis. Urology, 2008. 71: 17. https://pubmed.ncbi.nlm.nih.gov/18242357
261. Sandberg, T., *et al.* Ciprofloxacin for 7 days versus 14 days in women with acute pyelonephritis: a randomised, open-label and double-blind, placebo-controlled, non-inferiority trial. Lancet, 2012. 380: 484. https://pubmed.ncbi.nlm.nih.gov/22726802
262. van Nieuwkoop, C., *et al.* Treatment duration of febrile urinary tract infection: a pragmatic randomized, double-blind, placebo-controlled non-inferiority trial in men and women. BMC Med, 2017. 15: 70. https://pubmed.ncbi.nlm.nih.gov/28366170
263. Lafaurie, M., *et al.* Antimicrobial for 7 or 14 Days for Febrile Urinary Tract Infection in Men: A Multicenter Noninferiority Double-Blind, Placebo-Controlled, Randomized Clinical Trial. Clin Infect Dis, 2023. 76: 2154. https://pubmed.ncbi.nlm.nih.gov/36785526
264. Erba, L., *et al.* Short vs long-course antibiotic therapy in pyelonephritis: a comparison of systematic reviews and guidelines for the SIMI choosing wisely campaign. Intern Emerg Med, 2021. 16: 313. https://pubmed.ncbi.nlm.nih.gov/32566969
265. Nicolle, L.E. A practical guide to the management of complicated urinary tract infection. Drugs, 1997. 53: 583. https://pubmed.ncbi.nlm.nih.gov/9098661
266. Gould, C.V., *et al.* Guideline for prevention of catheter-associated urinary tract infections 2009. Infect Control Hosp Epidemiol, 2010. 31: 319. https://www.ncbi.nlm.nih.gov/pubmed/20156062
267. Magill, S.S., *et al.* Multistate point-prevalence survey of health care-associated infections. N Engl J Med, 2014. 370: 1198. https://www.ncbi.nlm.nih.gov/pubmed/24670166
268. Garibaldi, R.A., *et al.* Factors predisposing to bacteriuria during indwelling urethral catheterization. N Engl J Med, 1974. 291: 215. https://www.ncbi.nlm.nih.gov/pubmed/4834750
269. Kunin, C.M., *et al.* Prevention of catheter-induced urinary-tract infections by sterile closed drainage. N Engl J Med, 1966. 274: 1155. https://www.ncbi.nlm.nih.gov/pubmed/5934951
270. Hartstein, A.I., *et al.* Nosocomial urinary tract infection: a prospective evaluation of 108 catheterized patients. Infect Control, 1981. 2: 380. https://www.ncbi.nlm.nih.gov/pubmed/6795141

271. Warren, J.W., *et al.* Fever, bacteremia, and death as complications of bacteriuria in women with long-term urethral catheters. J Infect Dis, 1987. 155: 1151.
https://www.ncbi.nlm.nih.gov/pubmed/3572035
272. Classen, D.C., *et al.* Prevention of catheter-associated bacteriuria: clinical trial of methods to block three known pathways of infection. Am J Infect Control, 1991. 19: 136.
https://www.ncbi.nlm.nih.gov/pubmed/1863002
273. Saint, S., *et al.* Preventing catheter-related bacteriuria: should we? Can we? How? Arch Intern Med, 1999. 159: 800.
https://www.ncbi.nlm.nih.gov/pubmed/10219925
274. Maki, D.G., *et al.* Engineering out the risk for infection with urinary catheters. Emerg Infect Dis, 2001. 7: 342.
https://www.ncbi.nlm.nih.gov/pubmed/11294737
275. Li, F., *et al.* Risk factors for catheter-associated urinary tract infection among hospitalized patients: A systematic review and meta-analysis of observational studies. J Adv Nurs, 2019. 75: 517.
https://www.ncbi.nlm.nih.gov/pubmed/30259542
276. Jacobsen, S.M., *et al.* Complicated catheter-associated urinary tract infections due to Escherichia coli and Proteus mirabilis. Clin Microbiol Rev, 2008. 21: 26.
https://www.ncbi.nlm.nih.gov/pubmed/18202436
277. Geerlings, S.E., *et al.* SWAB Guidelines for Antimicrobial Therapy of Complicated Urinary Tract Infections in Adults. SWAB Guidelines, 2013.
https://swab.nl/exec/file/download/84
278. Durant, D.J. Nurse-driven protocols and the prevention of catheter-associated urinary tract infections: A systematic review. Am J Infect Control, 2017. 45: 1331.
https://www.ncbi.nlm.nih.gov/pubmed/28982611
279. Mody, L., *et al.* A targeted infection prevention intervention in nursing home residents with indwelling devices: a randomized clinical trial. JAMA Intern Med, 2015. 175: 714.
https://www.ncbi.nlm.nih.gov/pubmed/25775048
280. Meddings, J., *et al.* Systematic Review of Interventions to Reduce Urinary Tract Infection in Nursing Home Residents. J Hosp Med, 2017. 12: 356.
https://www.ncbi.nlm.nih.gov/pubmed/28459908
281. Kachare, S.D., *et al.* Toward eliminating catheter-associated urinary tract infections in an academic health center. J Surg Res, 2014. 192: 280.
https://www.ncbi.nlm.nih.gov/pubmed/25150082
282. Cao, Y., *et al.* Comparison of the preventive effect of urethral cleaning versus disinfection for catheter-associated urinary tract infections in adults: A network meta-analysis. Int J Infect Dis, 2018. 76: 102.
https://www.ncbi.nlm.nih.gov/pubmed/30243912
283. Noto, M.J., *et al.* Chlorhexidine bathing and health care-associated infections: a randomized clinical trial. JAMA, 2015. 313: 369.
https://www.ncbi.nlm.nih.gov/pubmed/25602496
284. Huang, H.P., *et al.* The efficacy of daily chlorhexidine bathing for preventing healthcare-associated infections in adult intensive care units. Korean J Intern Med, 2016. 31: 1159.
https://www.ncbi.nlm.nih.gov/pubmed/27048258
285. Li, M., *et al.* The effect of bladder catheterization on the incidence of urinary tract infection in laboring women with epidural analgesia: a meta-analysis of randomized controlled trials. Int Urogynecol J, 2019. 30: 1419.
https://www.ncbi.nlm.nih.gov/pubmed/30834958
286. Gibson, K.E., *et al.* Indwelling urethral versus suprapubic catheters in nursing home residents: determining the safest option for long-term use. J Hosp Infect, 2019. 102: 219.
https://www.ncbi.nlm.nih.gov/pubmed/30056015
287. Kidd, E.A., *et al.* Urethral (indwelling or intermittent) or suprapubic routes for short-term catheterisation in hospitalised adults. Cochrane Database Syst Rev, 2015. 2015: CD004203.
https://www.ncbi.nlm.nih.gov/pubmed/26661940
288. Jamison, J., *et al.* Catheter policies for management of long term voiding problems in adults with neurogenic bladder disorders. Cochrane Database Syst Rev, 2013. 18: CD004375.
https://www.ncbi.nlm.nih.gov/pubmed/24249436
289. Kranz, J., *et al.* Catheter-Associated Urinary Tract Infections in Adult Patients. Dtsch Arztebl Int, 2020. 117: 83.
https://www.ncbi.nlm.nih.gov/pubmed/32102727
290. Rognoni, C., *et al.* Intermittent catheterisation with hydrophilic and non-hydrophilic urinary catheters: systematic literature review and meta-analyses. BMC Urol, 2017. 17: 4.
https://www.ncbi.nlm.nih.gov/pubmed/28073354
291. Tradewell, M., *et al.* Systematic review and practice policy statements on urinary tract infection prevention in adults with spina bifida. Transl Androl Urol, 2018. 7: S205.
https://www.ncbi.nlm.nih.gov/pubmed/29928619

292. Akcam, F.Z., *et al.* An investigation of the effectiveness against bacteriuria of silver-coated catheters in short-term urinary catheter applications: A randomized controlled study. J Infect Chemother, 2019. 25: 797.
https://www.ncbi.nlm.nih.gov/pubmed/31030965
293. Singh, R., *et al.* Randomized controlled trial of silver-alloy-impregnated suprapubic catheters versus standard suprapubic catheters in assessing urinary tract infection rates in urogynecology patients. Int Urogynecol J, 2019. 30: 779.
https://www.ncbi.nlm.nih.gov/pubmed/30145671
294. Lam, T.B., *et al.* Types of indwelling urethral catheters for short-term catheterisation in hospitalised adults. Cochrane Database Syst Rev, 2014. 2014: CD004013.
https://www.ncbi.nlm.nih.gov/pubmed/25248140
295. Menezes, F.G., *et al.* A randomized clinical trial comparing Nitrofurazone-coated and uncoated urinary catheters in kidney transplant recipients: Results from a pilot study. Transpl Infect Dis, 2019. 21: e13031.
https://www.ncbi.nlm.nih.gov/pubmed/30451342
296. Bonfill, X., *et al.* Efficacy and safety of urinary catheters with silver alloy coating in patients with spinal cord injury: a multicentric pragmatic randomized controlled trial. The ESCALE trial. Spine J, 2017. 17: 1650.
https://www.ncbi.nlm.nih.gov/pubmed/28578163
297. Lusardi, G., *et al.* Antibiotic prophylaxis for short-term catheter bladder drainage in adults. Cochrane Database Syst Rev, 2013. 2013: CD005428.
https://www.ncbi.nlm.nih.gov/pubmed/23824735
298. Pickard, R., *et al.* Continuous low-dose antibiotic prophylaxis to prevent urinary tract infection in adults who perform clean intermittent self-catheterisation: the AnTIC RCT. Health Technol Assess, 2018. 22: 1.
https://www.ncbi.nlm.nih.gov/pubmed/29766842
299. Cek, M., *et al.* Healthcare-associated urinary tract infections in hospitalized urological patients--a global perspective: results from the GPIU studies 2003-2010. World J Urol, 2014. 32: 1587.
https://www.ncbi.nlm.nih.gov/pubmed/24452449
300. Darouiche, R.O., *et al.* Short versus long course of antibiotics for catheter-associated urinary tract infections in patients with spinal cord injury: a randomized controlled noninferiority trial. Arch Phys Med Rehabil, 2014. 95: 290.
https://www.ncbi.nlm.nih.gov/pubmed/24035770
301. Saint, S., *et al.* Preventing Catheter-Associated Urinary Tract Infections. N Engl J Med, 2016. 375: 1298.
https://www.ncbi.nlm.nih.gov/pubmed/27682041
302. Society of Critical Care Medicine. Surviving Sepsis Campaign Guidelines 2021.
https://www.sccm.org/clinical-resources/guidelines/guidelines/surviving-sepsis-guidelines-2021#Recommendations
303. Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften, S3-Leitlinie Urethritis: Management der Urethritis bei männlichen* Jugendlichen und Erwachsenen. 2024.
https://register.awmf.org/de/leitlinien/detail/013-099
304. Zhang, N., *et al.* Are Ureaplasma spp. a cause of nongonococcal urethritis? A systematic review and meta-analysis. PLoS One, 2014. 9: e113771.
https://www.ncbi.nlm.nih.gov/pubmed/25463970
305. Horner, P.J., *et al.* 2016 European guideline on the management of non-gonococcal urethritis. Int J STD AIDS, 2016. 27: 928.
https://www.ncbi.nlm.nih.gov/pubmed/27147267
306. Workowski, K.A., *et al.* Sexually transmitted diseases treatment guidelines, 2015. MMWR Recomm Rep, 2015. 64: 1.
https://www.ncbi.nlm.nih.gov/pubmed/26042815
307. Rietmeijer, C.A., *et al.* Recalibrating the Gram stain diagnosis of male urethritis in the era of nucleic acid amplification testing. Sex Transm Dis, 2012. 39: 18.
https://www.ncbi.nlm.nih.gov/pubmed/22183839
308. Couldwell, D.L., *et al.* Ureaplasma urealyticum is significantly associated with non-gonococcal urethritis in heterosexual Sydney men. Int J STD AIDS, 2010. 21: 337.
https://www.ncbi.nlm.nih.gov/pubmed/20498103
309. Berntsson, M., *et al.* Viral and bacterial aetiologies of male urethritis: findings of a high prevalence of Epstein-Barr virus. Int J STD AIDS, 2010. 21: 191.
https://www.ncbi.nlm.nih.gov/pubmed/20215624
310. Sarier, M., *et al.* Microscopy of Gram-stained urethral smear in the diagnosis of urethritis: Which threshold value should be selected? Andrologia, 2018. 50: e13143.
https://www.ncbi.nlm.nih.gov/pubmed/30238498
311. Moi, H., *et al.* Microscopy of Stained Urethral Smear in Male Urethritis; Which Cutoff Should be Used? Sex Transm Dis, 2017. 44: 189.
https://www.ncbi.nlm.nih.gov/pubmed/28178118

312. Mensforth, S., *et al.* Auditing the use and assessing the clinical utility of microscopy as a point-of-care test for Neisseria gonorrhoeae in a Sexual Health clinic. Int J STD AIDS, 2018. 29: 157.
https://www.ncbi.nlm.nih.gov/pubmed/28705094
313. Atkinson, L.M., *et al.* 'The waiting game': are current chlamydia and gonorrhoea near-patient/point-of-care tests acceptable to service users and will they impact on treatment? Int J STD AIDS, 2016. 27: 650.
https://www.ncbi.nlm.nih.gov/pubmed/26092579
314. Harding-Esch, E.M., *et al.* Impact of deploying multiple point-of-care tests with a 'sample first' approach on a sexual health clinical care pathway. A service evaluation. Sex Transm Infect, 2017. 93: 424.
https://www.ncbi.nlm.nih.gov/pubmed/28159916
315. Jensen, J.S., *et al.* 2016 European guideline on Mycoplasma genitalium infections. J Eur Acad Dermatol Venereol, 2016. 30: 1650.
https://www.ncbi.nlm.nih.gov/pubmed/27505296
316. Centers for Disease, C., *et al.* Recommendations for the laboratory-based detection of Chlamydia trachomatis and Neisseria gonorrhoeae--2014. MMWR Recomm Rep, 2014. 63: 1.
https://www.ncbi.nlm.nih.gov/pubmed/24622331
317. Miller, J.M., *et al.* A Guide to Utilization of the Microbiology Laboratory for Diagnosis of Infectious Diseases: 2018 Update by the Infectious Diseases Society of America and the American Society for Microbiology. Clin Infect Dis, 2018. 67: e1.
https://www.ncbi.nlm.nih.gov/pubmed/29955859
318. Sena, A.C., *et al.* Persistent and recurrent Trichomonas vaginalis infections: epidemiology, treatment and management considerations. Expert Rev Anti Infect Ther, 2014. 12: 673.
https://www.ncbi.nlm.nih.gov/pubmed/24555561
319. Falk, L., *et al.* Time to eradication of Mycoplasma genitalium after antibiotic treatment in men and women. J Antimicrob Chemother, 2015. 70: 3134.
https://www.ncbi.nlm.nih.gov/pubmed/26283670
320. Ong, J.J., *et al.* Should Female Partners of Men With Non-Gonococcal Urethritis, Negative for Chlamydia trachomatis and Mycoplasma genitalium, Be Informed and Treated? Clinical Outcomes From a Partner Study of Heterosexual Men With NGU. Sex Transm Dis, 2017. 44: 126.
https://www.ncbi.nlm.nih.gov/pubmed/28079749
321. Kirkcaldy, R.D., *et al.* The efficacy and safety of gentamicin plus azithromycin and gemifloxacin plus azithromycin as treatment of uncomplicated gonorrhea. Clin Infect Dis, 2014. 59: 1083.
https://www.ncbi.nlm.nih.gov/pubmed/25031289
322. Hathorn, E., *et al.* The effectiveness of gentamicin in the treatment of Neisseria gonorrhoeae: a systematic review. Syst Rev, 2014. 3: 104.
https://www.ncbi.nlm.nih.gov/pubmed/25239090
323. Soda, M., *et al.* Evaluation of the Microbiological Efficacy of a Single 2-Gram Dose of Extended-Release Azithromycin by Population Pharmacokinetics and Simulation in Japanese Patients with Gonococcal Urethritis. Antimicrob Agents Chemother, 2018. 62: e01409.
https://www.ncbi.nlm.nih.gov/pubmed/29038284
324. Takahashi, S., *et al.* Clinical Efficacy of a Single Two Gram Dose of Azithromycin Extended Release for Male Patients with Urethritis. Antibiotics (Basel), 2014. 3: 109.
https://www.ncbi.nlm.nih.gov/pubmed/27025738
325. Yasuda, M., *et al.* A single 2 g oral dose of extended-release azithromycin for treatment of gonococcal urethritis. J Antimicrob Chemother, 2014. 69: 3116.
https://www.ncbi.nlm.nih.gov/pubmed/24948703
326. Kojima, M., *et al.* Single-dose treatment of male patients with gonococcal urethritis using 2g spectinomycin: microbiological and clinical evaluations. Int J Antimicrob Agents, 2008. 32: 50.
https://www.ncbi.nlm.nih.gov/pubmed/18539003
327. Moran, J.S., *et al.* Drugs of choice for the treatment of uncomplicated gonococcal infections. Clin Infect Dis, 1995. 20 Suppl 1: S47.
https://www.ncbi.nlm.nih.gov/pubmed/7795109
328. Yuan, Z., *et al.* Randomized controlled clinical trial on the efficacy of fosfomycin trometamol for uncomplicated gonococcal urethritis in men. Clin Microbiol Infect, 2016. 22: 507.
https://www.ncbi.nlm.nih.gov/pubmed/27064136
329. Lanjouw, E., *et al.* 2015 European guideline on the management of Chlamydia trachomatis infections. Int J STD AIDS, 2016. 27: 333.
https://www.ncbi.nlm.nih.gov/pubmed/26608577
330. Manhart, L.E., *et al.* Efficacy of Antimicrobial Therapy for Mycoplasma genitalium Infections. Clin Infect Dis, 2015. 61 Suppl 8: S802.
https://www.ncbi.nlm.nih.gov/pubmed/26602619

331. Khosropour, C.M., *et al.* Efficacy of standard therapies against Ureaplasma species and persistence among men with non-gonococcal urethritis enrolled in a randomised controlled trial. Sex Transm Infect, 2015. 91: 308. https://www.ncbi.nlm.nih.gov/pubmed/25616607
332. Wagenlehner, F.M., *et al.* The Presentation, Diagnosis, and Treatment of Sexually Transmitted Infections. Dtsch Arztebl Int, 2016. 113: 11. https://www.ncbi.nlm.nih.gov/pubmed/26931526
333. Muratani, T., *et al.* Single dose 1 g ceftriaxone for urogenital and pharyngeal infection caused by Neisseria gonorrhoeae. Int J Urol, 2008. 15: 837. https://www.ncbi.nlm.nih.gov/pubmed/18665871
334. Alexander, R.B., *et al.* Elevated levels of proinflammatory cytokines in the semen of patients with chronic prostatitis/chronic pelvic pain syndrome. Urology, 1998. 52: 744. https://www.ncbi.nlm.nih.gov/pubmed/9801092
335. Alexander, R.B., *et al.* Chronic prostatitis: results of an Internet survey. Urology, 1996. 48: 568. https://www.ncbi.nlm.nih.gov/pubmed/8886062
336. Zermann, D.H., *et al.* Neurourological insights into the etiology of genitourinary pain in men. J Urol, 1999. 161: 903. https://www.ncbi.nlm.nih.gov/pubmed/10022711
337. Perletti, G., *et al.* Antimicrobial therapy for chronic bacterial prostatitis. Cochrane Database Syst Rev, 2013: CD009071. https://www.ncbi.nlm.nih.gov/pubmed/23934982
338. Dadashpour. M, *et al.* Acute Prostatitis After Transrectal Ultrasound-guided Prostate Biopsy: Comparing Two Different Antibiotic Prophylaxis Regimen. Biomed Pharmacol J, 2016. 9: 593. https://biomedpharmajournal.org/vol9no2/acute-prostatitis-after-transrectal-ultrasound-guided-prostate-biopsy-comparing-two-different-antibiotic-prophylaxis-regimen/
339. Schaeffer, A.J., *et al.* Treatment of chronic bacterial prostatitis with levofloxacin and ciprofloxacin lowers serum prostate specific antigen. J Urol, 2005. 174: 161. https://www.ncbi.nlm.nih.gov/pubmed/15947609
340. Skerk, V., *et al.* Comparative analysis of azithromycin and ciprofloxacin in the treatment of chronic prostatitis caused by Chlamydia trachomatis. Int J Antimicrob Agents, 2003. 21: 457. https://www.ncbi.nlm.nih.gov/pubmed/12727080
341. Vickovic, N., *et al.* Metronidazole 1.5 gram dose for 7 or 14 days in the treatment of patients with chronic prostatitis caused by Trichomonas vaginalis: A randomized study. J Chemother, 2010. 22: 364. https://www.ncbi.nlm.nih.gov/pubmed/21123162
342. Cai, T., *et al.* Serenoa repens associated with Urtica dioica (ProstaMEV) and curcumin and quercitin (FlogMEV) extracts are able to improve the efficacy of prulifloxacin in bacterial prostatitis patients: results from a prospective randomised study. Int J Antimicrob Agents, 2009. 33: 549. https://www.ncbi.nlm.nih.gov/pubmed/19181486
343. Aliaev Iu, G., *et al.* [Wardenafil in combined treatment of patients with chronic bacterial prostatitis]. Urologiia, 2008: 52. https://www.ncbi.nlm.nih.gov/pubmed/19256057
344. Lipsky, B.A., *et al.* Treatment of bacterial prostatitis. Clin Infect Dis, 2010. 50: 1641. https://www.ncbi.nlm.nih.gov/pubmed/20459324
345. Wise, G.J., *et al.* Atypical infections of the prostate. Current Prostate Reports, 2008. 6: 86. https://link.springer.com/article/10.1007/s11918-008-0014-2
346. Turner, J.A., *et al.* Validity and responsiveness of the national institutes of health chronic prostatitis symptom index. J Urol, 2003. 169: 580. https://www.ncbi.nlm.nih.gov/pubmed/12544311
347. Zegarra Montes, L.Z., *et al.* Semen and urine culture in the diagnosis of chronic bacterial prostatitis. Int Braz J Urol, 2008. 34: 30. https://www.ncbi.nlm.nih.gov/pubmed/18341719
348. Budia, A., *et al.* Value of semen culture in the diagnosis of chronic bacterial prostatitis: a simplified method. Scand J Urol Nephrol, 2006. 40: 326. https://www.ncbi.nlm.nih.gov/pubmed/16916775
349. Skerk, V., *et al.* The role of unusual pathogens in prostatitis syndrome. Int J Antimicrob Agents, 2004. 24 Suppl 1: S53. https://www.ncbi.nlm.nih.gov/pubmed/15364308
350. Schneider, H., *et al.* The 2001 Giessen Cohort Study on patients with prostatitis syndrome--an evaluation of inflammatory status and search for microorganisms 10 years after a first analysis. Andrologia, 2003. 35: 258. https://www.ncbi.nlm.nih.gov/pubmed/14535851

351. Naber, K.G., *et al.*, Prostatitits, epididymitis and orchitis, in Infectious diseases, D. Armstrong & J. Cohen, Editors. 1999, Mosby: London.
352. Badalyan, R.R., *et al.* Chlamydial and ureaplasmal infections in patients with nonbacterial chronic prostatitis. Andrologia, 2003. 35: 263. https://www.ncbi.nlm.nih.gov/pubmed/14535852
353. Berger, R.E., Epididymitis., in Sexually transmitted diseases, K.K. Holmes, P.-A. Mardh, P.F. Sparling & P.J. Wiesner, Editors. 1984, McGraw-Hill: New York.
354. Robinson, A.J., *et al.* Acute epididymitis: why patient and consort must be investigated. Br J Urol, 1990. 66: 642. https://www.ncbi.nlm.nih.gov/pubmed/2265337
355. Schaeffer, A.J. Prostatitis: US perspective. Int J Antimicrob Agents, 1999. 11: 205. https://www.ncbi.nlm.nih.gov/pubmed/10394972
356. Krieger, J.N., *et al.* NIH consensus definition and classification of prostatitis. JAMA, 1999. 282: 236. https://www.ncbi.nlm.nih.gov/pubmed/10422990
357. Workshop Committee of the National Institute of Diabetes and Digestive and Kidney Disease (NIDDK), Chronic prostatitis workshop. 1995: Bethesda, Maryland.
358. Krieger, J.N., *et al.* Chronic pelvic pains represent the most prominent urogenital symptoms of "chronic prostatitis". Urology, 1996. 48: 715. https://www.ncbi.nlm.nih.gov/pubmed/8911515
359. Nickel, J.C. Effective office management of chronic prostatitis. Urol Clin North Am, 1998. 25: 677. https://www.ncbi.nlm.nih.gov/pubmed/10026774
360. Etienne, M., *et al.* Performance of the urine leukocyte esterase and nitrite dipstick test for the diagnosis of acute prostatitis. Clin Infect Dis, 2008. 46: 951. https://www.ncbi.nlm.nih.gov/pubmed/18288905
361. Meares, E.M., *et al.* Bacteriologic localization patterns in bacterial prostatitis and urethritis. Invest Urol, 1968. 5: 492. https://www.ncbi.nlm.nih.gov/pubmed/4870505
362. Nickel, J.C., *et al.* How does the pre-massage and post-massage 2-glass test compare to the Meares-Stamey 4-glass test in men with chronic prostatitis/chronic pelvic pain syndrome? J Urol, 2006. 176: 119. https://www.ncbi.nlm.nih.gov/pubmed/16753385
363. Doble, A., *et al.* Ultrasonographic findings in prostatitis. Urol Clin North Am, 1989. 16: 763. https://www.ncbi.nlm.nih.gov/pubmed/2683305
364. Papp, J.R., *et al.* Recommendations for the Laboratory-Based Detection of Chlamydia trachomatis and Neisseria gonorrhoeae — 2014. MMWR Recomm Rep, 2014. 63: 1. https://pubmed.ncbi.nlm.nih.gov/24622331
365. Polascik, T.J., *et al.* Prostate specific antigen: a decade of discovery--what we have learned and where we are going. J Urol, 1999. 162: 293. https://www.ncbi.nlm.nih.gov/pubmed/10411025
366. Wagenlehner, F.M., *et al.* Bacterial prostatitis. World J Urol, 2013. 31: 711. https://www.ncbi.nlm.nih.gov/pubmed/23519458
367. Gill, B.C., *et al.* Bacterial prostatitis. Curr Opin Infect Dis, 2016. 29: 86. https://www.ncbi.nlm.nih.gov/pubmed/26555038
368. Wagenlehner, F.M., *et al.* Prostatitis: the role of antibiotic treatment. World J Urol, 2003. 21: 105. https://www.ncbi.nlm.nih.gov/pubmed/12687400
369. Krieger, J.N. Recurrent lower urinary tract infections in men. J New Rem Clin, 1998. 47: 4. https://www.sciencedirect.com/science/article/abs/pii/S0022534717362924
370. Litwin, M.S., *et al.* The National Institutes of Health chronic prostatitis symptom index: development and validation of a new outcome measure. Chronic Prostatitis Collaborative Research Network. J Urol, 1999. 162: 369. https://www.ncbi.nlm.nih.gov/pubmed/10411041
371. Schaeffer, A.J., *et al.* Summary consensus statement: diagnosis and management of chronic prostatitis/chronic pelvic pain syndrome. Eur Urol 2003. 43: 1. https://www.sciencedirect.com/science/article/abs/pii/S1569905602001914
372. Bjerklund Johansen, T.E., *et al.* The role of antibiotics in the treatment of chronic prostatitis: a consensus statement. Eur Urol, 1998. 34: 457. https://www.ncbi.nlm.nih.gov/pubmed/9831786
373. Cai, T., *et al.* Clinical and microbiological efficacy of prulifloxacin for the treatment of chronic bacterial prostatitis due to Chlamydia trachomatis infection: results from a prospective, randomized and open-label study. Methods Find Exp Clin Pharmacol, 2010. 32: 39. https://www.ncbi.nlm.nih.gov/pubmed/20383345

374. Smelov, V., *et al.* Chlamydia trachomatis survival in the presence of two fluoroquinolones (lomefloxacin versus levofloxacin) in patients with chronic prostatitis syndrome. Andrologia, 2005. 37: 61.
https://www.ncbi.nlm.nih.gov/pubmed/16026425
375. Ohkawa, M., *et al.* Antimicrobial treatment for chronic prostatitis as a means of defining the role of Ureaplasma urealyticum. Urol Int, 1993. 51: 129.
https://www.ncbi.nlm.nih.gov/pubmed/8249222
376. Jimenez-Cruz, J.F., *et al.* Treatment of chronic prostatitis: intraprostatic antibiotic injections under echography control. J Urol, 1988. 139: 967.
https://www.ncbi.nlm.nih.gov/pubmed/3283385
377. Mayersak, J.S. Transrectal ultrasonography directed intraprostatic injection of gentamycin-xylocaine in the management of the benign painful prostate syndrome. A report of a 5 year clinical study of 75 patients. Int Surg, 1998. 83: 347.
https://www.ncbi.nlm.nih.gov/pubmed/10096759
378. Hua, L.X., *et al.* [The diagnosis and treatment of acute prostatitis: report of 35 cases]. Zhonghua Nan Ke Xue, 2005. 11: 897.
https://www.ncbi.nlm.nih.gov/pubmed/16398358
379. Yoon, B.I., *et al.* Acute bacterial prostatitis: how to prevent and manage chronic infection? J Infect Chemother, 2012. 18: 444.
https://www.ncbi.nlm.nih.gov/pubmed/22215226
380. Ludwig, M., *et al.* Diagnosis and therapeutic management of 18 patients with prostatic abscess. Urology, 1999. 53: 340.
https://www.ncbi.nlm.nih.gov/pubmed/9933051
381. Chou, Y.H., *et al.* Prostatic abscess: transrectal color Doppler ultrasonic diagnosis and minimally invasive therapeutic management. Ultrasound Med Biol, 2004. 30: 719.
https://www.ncbi.nlm.nih.gov/pubmed/15219951
382. Çek, M., *et al.* Acute and Chronic Epididymitis in EAU-EBU Update Series. Eur Urol Suppl 2017. 16: 124.
https://www.sciencedirect.com/science/article/abs/pii/S1569905617300568
383. Pilatz, A., *et al.* Acute epididymitis revisited: impact of molecular diagnostics on etiology and contemporary guideline recommendations. Eur Urol, 2015. 68: 428.
https://www.ncbi.nlm.nih.gov/pubmed/25542628
384. Harnisch, J.P., *et al.* Aetiology of acute epididymitis. Lancet, 1977. 1: 819.
https://www.ncbi.nlm.nih.gov/pubmed/67333
385. Shigemura, K., *et al.* Risk factors for febrile genito-urinary infection in the catheterized patients by with spinal cord injury-associated chronic neurogenic lower urinary tract dysfunction evaluated by urodynamic study and cystography: a retrospective study. World J Urol, 2020. 38: 733.
https://www.ncbi.nlm.nih.gov/pubmed/30949801
386. Street, E., *et al.* The 2016 European guideline on the management of epididymo-orchitis. IUSTI, 2016.
https://www.ncbi.nlm.nih.gov/pubmed/28632112
387. Chirwa, M., *et al.* United Kingdom British association for sexual health and HIV national guideline for the management of epididymo-orchitis, 2020. Int J STD AIDS, 2021. 32: 884.
https://www.ncbi.nlm.nih.gov/pubmed/34009058
388. Abbara, A., *et al.* Etiology and management of genitourinary tuberculosis. Nat Rev Urol, 2011. 8: 678.
https://www.ncbi.nlm.nih.gov/pubmed/22157940
389. Zitek, T., *et al.* Assessing the Utility of Ultrasound and Urinalysis for Patients with Possible Epididymo-Orchitis - A Retrospective Study. Open Access Emerg Med, 2020. 12: 47.
https://www.ncbi.nlm.nih.gov/pubmed/32214857
390. Capet, J., *et al.* Is follow-up ultrasound necessary after acute epididymitis? A retrospective analysis from a large university hospital. Scand J Urol, 2018. 52: 445.
https://www.ncbi.nlm.nih.gov/pubmed/30600755
391. Sadahira, T., *et al.* Clinical pharmacokinetics of oral levofloxacin and sitafloxacin in epididymal tissue. J Infect Chemother, 2017. 23: 214.
https://www.ncbi.nlm.nih.gov/pubmed/28089362
392. Street, E., *et al.* BASHH 2010 United Kingdom national guideline for the management of epididymo-orchitis. 2010.
http://www.bashh.org/documents/3546.pdf
393. Fifer, H., *et al.* 2018 UK national guideline for the management of infection with Neisseria gonorrhoeae. Int J STD AIDS, 2020. 31: 4.
https://www.ncbi.nlm.nih.gov/pubmed/31870237

394. Eickhoff, J.H., *et al.* A double-blind, randomized, controlled multicentre study to compare the efficacy of ciprofloxacin with pivampicillin as oral therapy for epididymitis in men over 40 years of age. BJU Int, 1999. 84: 827.
https://www.ncbi.nlm.nih.gov/pubmed/10532980
395. Banyra, O., *et al.* Acute epididymo-orchitis: relevance of local classification and partner's follow-up. Cent European J Urol, 2019. 72: 324.
https://www.ncbi.nlm.nih.gov/pubmed/31720038
396. Pilatz, A., *et al.* Impact of Bacterial Epididymitis on Semen Quality after Antibiotic Treatment. J Urol, 2012. 187: e443.
https://www.auajournals.org/doi/10.1016/j.juro.2012.02.1199
397. Haddadeen, C., *et al.* Comparative regional audit of urology and genito-urinary departments in the management of acute epididymo-orchitis. HIV Medicine, 2010. 11: 45.
https://www.researchgate.net/publication/295130036
398. Nicholson, A., *et al.* Management of epididymo-orchitis in primary care: results from a large UK primary care database. Br J Gen Pract, 2010. 60: e407.
https://www.ncbi.nlm.nih.gov/pubmed/20883615
399. Andersen, B., *et al.* Impact of intensified testing for urogenital Chlamydia trachomatis infections: a randomised study with 9-year follow-up. Sex Transm Infect, 2011. 87: 156.
https://www.ncbi.nlm.nih.gov/pubmed/21097811
400. Chennamsetty, A., *et al.* Contemporary diagnosis and management of Fournier's gangrene. Ther Adv Urol, 2015. 7: 203.
https://www.ncbi.nlm.nih.gov/pubmed/26445600
401. Eke, N. Fournier's gangrene: a review of 1726 cases. Br J Surg, 2000. 87: 718.
https://www.ncbi.nlm.nih.gov/pubmed/10848848
402. Subrahmanyam, U., *et al.* Honey dressing beneficial in treatment of fournier's gangrene. Indian J Surg, 2004. 66: 75.
https://www.researchgate.net/publication/289257622
403. Jallali, N., *et al.* Hyperbaric oxygen as adjuvant therapy in the management of necrotizing fasciitis. Am J Surg, 2005. 189: 462.
https://pubmed.ncbi.nlm.nih.gov/15820462
404. Karian, L.S., *et al.* Reconstruction of Defects After Fournier Gangrene: A Systematic Review. Eplasty, 2015. 15: e18.
https://www.ncbi.nlm.nih.gov/pubmed/26171090
405. Furr, J., *et al.* Contemporary Trends in the Inpatient Management of Fournier's Gangrene: Predictors of Length of Stay and Mortality Based on Population-based Sample. Urology, 2017. 102: 79.
https://www.ncbi.nlm.nih.gov/pubmed/27693572
406. Kim, S.Y., *et al.* A contemporary analysis of Fournier gangrene using the National Surgical Quality Improvement Program. Urology, 2015. 85: 1052.
https://www.ncbi.nlm.nih.gov/pubmed/25770725
407. Sorensen, M.D., *et al.* Fournier's Gangrene: Epidemiology and Outcomes in the General US Population. Urol Int, 2016. 97: 249.
https://www.ncbi.nlm.nih.gov/pubmed/27172977
408. Roghmann, F., *et al.* Is there a need for the Fournier's gangrene severity index? Comparison of scoring systems for outcome prediction in patients with Fournier's gangrene. BJU International, 2012. 110: 1359.
https://pubmed.ncbi.nlm.nih.gov/22494217
409. Lauerman, M.H., *et al.* Less is more? Antibiotic duration and outcomes in Fournier's gangrene. J Trauma Acute Care Surg, 2017. 83: 443.
https://www.ncbi.nlm.nih.gov/pubmed/28538648
410. Li, C., *et al.* Hyperbaric oxygen therapy as an adjuvant therapy for comprehensive treatment of Fournier's gangrene. Urologia Internationalis, 2015. 94: 453.
https://pubmed.ncbi.nlm.nih.gov/25677386/
411. Stevens, D.L., *et al.* Practice guidelines for the diagnosis and management of skin and soft tissue infections: 2014 update by the infectious diseases society of America. Clin Infect Dis, 2014. 59: 147.
https://www.ncbi.nlm.nih.gov/pubmed/24947530
412. Lyu, Z., *et al.* Human papillomavirus in semen and the risk for male infertility: a systematic review and meta-analysis. BMC Infect Dis, 2017. 17: 714.
https://www.ncbi.nlm.nih.gov/pubmed/29121862
413. Rodriguez-Alvarez, M.I., *et al.* Prevalence and Risk Factors of Human Papillomavirus in Male Patients: A Systematic Review and Meta-Analysis. Int J Environ Res Public Health, 2018. 15: 2210.
https://www.ncbi.nlm.nih.gov/pubmed/30309014

414. Vaccarella, S., *et al.* Clustering of human papillomavirus (HPV) types in the male genital tract: the HPV in men (HIM) study. J Infect Dis, 2011. 204: 1500.
https://www.ncbi.nlm.nih.gov/pubmed/21908729
415. Nakashima, K., *et al.* Risk factors for human papillomavirus detection in urine samples of heterosexual men visiting urological clinics in Japan. J Infect Chemother, 2018. 24: 713.
https://www.ncbi.nlm.nih.gov/pubmed/29759898
416. Luttmer, R., *et al.* Presence of human papillomavirus in semen in relation to semen quality. Hum Reprod, 2016. 31: 280.
https://www.ncbi.nlm.nih.gov/pubmed/26724799
417. Souho, T., *et al.* Human papillomavirus infection and fertility alteration: a systematic review. PLoS One, 2015. 10: e0126936.
https://www.ncbi.nlm.nih.gov/pubmed/25992782
418. Azevedo, J., *et al.* Epidemiology of human papillomavirus on anogenital warts in Portugal - The HERCOLES study. J Eur Acad Dermatol Venereol, 2017. 31: 1342.
https://www.ncbi.nlm.nih.gov/pubmed/28485812
419. Wei, F., *et al.* Sex Differences in the Incidence and Clearance of Anogenital Human Papillomavirus Infection in Liuzhou, China: An Observational Cohort Study. Clin Infect Dis, 2020. 70: 82.
https://www.ncbi.nlm.nih.gov/pubmed/30852604
420. Harder, T., *et al.* Efficacy, effectiveness and safety of vaccination against human papillomavirus in males: a systematic review. BMC Med, 2018. 16: 110.
https://www.ncbi.nlm.nih.gov/pubmed/30016957
421. Shigeishi, H., *et al.* Risk Factors for Oral Human Papillomavirus Infection in Healthy Individuals: A Systematic Review and Meta-Analysis. J Clin Med Res, 2016. 8: 721.
https://www.ncbi.nlm.nih.gov/pubmed/27635177
422. Tam, S., *et al.* The epidemiology of oral human papillomavirus infection in healthy populations: A systematic review and meta-analysis. Oral Oncol, 2018. 82: 91.
https://www.ncbi.nlm.nih.gov/pubmed/29909908
423. Dalla Torre, D., *et al.* The impact of sexual behavior on oral HPV infections in young unvaccinated adults. Clin Oral Investig, 2016. 20: 1551.
https://www.ncbi.nlm.nih.gov/pubmed/26526324
424. Geskus, R.B., *et al.* Incidence and clearance of anal high-risk human papillomavirus in HIV-positive men who have sex with men: estimates and risk factors. AIDS (london, england), 2016. 30: 37.
https://pubmed.ncbi.nlm.nih.gov/26355673
425. Hebnes, J.B., *et al.* Prevalence of genital human papillomavirus among men in Europe: systematic review and meta-analysis. J Sex Med, 2014. 11: 2630.
https://www.ncbi.nlm.nih.gov/pubmed/25088239
426. Kaderli, R., *et al.* The impact of smoking on HPV infection and the development of anogenital warts. Int J Colorectal Dis, 2014. 29: 899.
https://www.ncbi.nlm.nih.gov/pubmed/24935346
427. Liu, M., *et al.* Transmission of genital human papillomavirus infection in couples: a population-based cohort study in rural China. Sci Rep, 2015. 5: 10986.
https://www.ncbi.nlm.nih.gov/pubmed/26204471
428. Taylor, S., *et al.* The incidence, clearance and persistence of non-cervical human papillomavirus infections: a systematic review of the literature. BMC Infect Dis, 2016. 16: 293.
https://www.ncbi.nlm.nih.gov/pubmed/27301867
429. Albero, G., *et al.* Male circumcision and prevalence of genital human papillomavirus infection in men: a multinational study. BMC Infect Dis, 2013. 13: 18.
https://www.ncbi.nlm.nih.gov/pubmed/23327450
430. Lam, J.U., *et al.* Condom use in prevention of Human Papillomavirus infections and cervical neoplasia: systematic review of longitudinal studies. J Med Screen, 2014. 21: 38.
https://www.ncbi.nlm.nih.gov/pubmed/24488594
431. Larke, N., *et al.* Male circumcision and human papillomavirus infection in men: a systematic review and meta-analysis. J Infect Dis, 2011. 204: 1375.
https://www.ncbi.nlm.nih.gov/pubmed/21965090
432. Liu, Z., *et al.* Penises not required: a systematic review of the potential for human papillomavirus horizontal transmission that is non-sexual or does not include penile penetration. Sex Health, 2016. 13: 10.
https://www.ncbi.nlm.nih.gov/pubmed/26433493
433. Albero, G., *et al.* Male circumcision and genital human papillomavirus: a systematic review and meta-analysis. Sex Transm Dis, 2012. 39: 104.
https://www.ncbi.nlm.nih.gov/pubmed/22249298

434. Zaak, D., *et al.* Recurrence of condylomata acuminata of the urethra after conventional and fluorescence-controlled Nd:YAG laser treatment. Urology, 2003. 61: 1011.
https://www.ncbi.nlm.nih.gov/pubmed/12736026
435. Vives, A., *et al.* Urethral condylomas in men: experience in 123 patients without previous treatment. Int J STD AIDS, 2016. 27: 39.
https://www.ncbi.nlm.nih.gov/pubmed/25712107
436. Gilson, R., *et al.* 2019 IUSTI-Europe guideline for the management of anogenital warts. J Eur Acad Dermatol Venereol, 2020. 34: 1644.
https://www.ncbi.nlm.nih.gov/pubmed/32735077
437. Edwards, L., *et al.* Self-administered topical 5% imiquimod cream for external anogenital warts. HPV Study Group. Human PapillomaVirus. Arch Dermatol, 1998. 134: 25.
https://www.ncbi.nlm.nih.gov/pubmed/9449906
438. Saiag, P., *et al.* Imiquimod 5% cream for external genital or perianal warts in human immunodeficiency virus-positive patients treated with highly active antiretroviral therapy: an open-label, noncomparative study. Br J Dermatol, 2009. 161: 904.
https://www.ncbi.nlm.nih.gov/pubmed/19466962
439. Grillo-Ardila, C.F., *et al.* Imiquimod for anogenital warts in non-immunocompromised adults. Cochrane Database Syst Rev, 2014: CD010389.
https://www.ncbi.nlm.nih.gov/pubmed/25362229
440. Tatti, S., *et al.* Sinecatechins, a defined green tea extract, in the treatment of external anogenital warts: a randomized controlled trial. Obstet Gynecol, 2008. 111: 1371.
https://www.ncbi.nlm.nih.gov/pubmed/18515521
441. Puviani, M., *et al.* Efficacy of sinecatechins 10% as proactive sequential therapy of external genital warts after laser CO(2) ablative therapy: The PACT study (post-ablation immunomodulator treatment of condylomata with sinecatechins): a randomized, masked outcome assessment, multicenter trial. Int J STD AIDS, 2019. 30: 131.
https://www.ncbi.nlm.nih.gov/pubmed/30236042
442. Werner, R.N., *et al.* Self-administered interventions for anogenital warts in immunocompetent patients: a systematic review and meta-analysis. Sex Transm Infect, 2017. 93: 155.
https://www.ncbi.nlm.nih.gov/pubmed/27803240
443. Camargo, C.L., *et al.* A prospective, open, comparative study of 5% potassium hydroxide solution versus cryotherapy in the treatment of genital warts in men. An Bras Dermatol, 2014. 89: 236.
https://www.ncbi.nlm.nih.gov/pubmed/24770498
444. Kodner, C.M., *et al.* Management of genital warts. Am Fam Physician, 2004. 70: 2335.
https://www.ncbi.nlm.nih.gov/pubmed/15617297
445. Scheinfeld, N., *et al.* An evidence-based review of medical and surgical treatments of genital warts. Dermatol Online J, 2006. 12: 5.
https://www.ncbi.nlm.nih.gov/pubmed/16638419
446. Barton, S., *et al.* Effectiveness of topical and ablative therapies in treatment of anogenital warts: a systematic review and network meta-analysis. BMJ Open, 2019. 9: e027765.
https://www.ncbi.nlm.nih.gov/pubmed/31676644
447. Tobian, A.A., *et al.* Male circumcision for the prevention of HSV-2 and HPV infections and syphilis. N Engl J Med, 2009. 360: 1298.
https://www.ncbi.nlm.nih.gov/pubmed/19321868
448. Schmeler, K.M., *et al.* Expanding the benefits of HPV vaccination to boys and men. Lancet, 2016. 387: 1798.
https://www.ncbi.nlm.nih.gov/pubmed/27203488
449. Rosales, R., *et al.* Regression of human papillomavirus intraepithelial lesions is induced by MVA E2 therapeutic vaccine. Hum Gene Ther, 2014. 25: 1035.
https://www.ncbi.nlm.nih.gov/pubmed/25275724
450. Mikamo, H., *et al.* Efficacy, safety, and immunogenicity of a quadrivalent HPV vaccine in Japanese men: A randomized, Phase 3, placebo-controlled study. Vaccine, 2019. 37: 1651.
https://www.ncbi.nlm.nih.gov/pubmed/30797638
451. Bergman, H., *et al.* Comparison of different human papillomavirus (HPV) vaccine types and dose schedules for prevention of HPV-related disease in females and males. Cochrane Database Syst Rev, 2019. 2019: CD013479.
https://www.ncbi.nlm.nih.gov/pubmed/31755549
452. Dibble, K.E., *et al.* A Systematic Literature Review of HPV Vaccination Barriers Among Adolescent and Young Adult Males. J Adolesc Young Adult Oncol, 2019. 8: 495.
https://www.ncbi.nlm.nih.gov/pubmed/31090474
453. Richman, A.R., *et al.* A randomized intervention study to evaluate whether electronic messaging can increase HPV vaccine uptake and knowledge. J Am Coll Health, 2016. 20: S28.
https://pubmed.ncbi.nlm.nih.gov/26821923

454. Dabestani, N., *et al.* Time Trends in First-Episode Genital Herpes Simplex Virus Infections in an Urban Sexually Transmitted Disease Clinic. Sex Transm Dis, 2019. 46: 795.
https://pubmed.ncbi.nlm.nih.gov/31764767
455. Yousuf, W., *et al.* Herpes simplex virus type 1 in Europe: systematic review, meta-analyses and meta-regressions. BMJ Glob Health, 2020. 5.
https://www.ncbi.nlm.nih.gov/pubmed/32675066
456. Aimukdad, S., *et al.* Epidemiology of herpes simplex virus type 1 and genital herpes in Australia and New Zealand: systematic review, meta-analyses and meta-regressions. Epidemiol Infect, 2023. 151: e33.
https://www.ncbi.nlm.nih.gov/pubmed/36750224
457. Alareeki, A., *et al.* Epidemiology of herpes simplex virus type 2 in Europe: systematic review, meta-analyses, and meta-regressions. Lancet Reg Health Eur, 2023. 25: 100558.
https://www.ncbi.nlm.nih.gov/pubmed/36818238
458. Aimukdad, S., *et al.* Epidemiology of herpes simplex virus type 2 in Asia: A systematic review, meta-analysis, and meta-regression. Lancet Reg Health West Pac, 2021. 12: 100176.
https://www.ncbi.nlm.nih.gov/pubmed/34527970
459. Aimukdad, S., *et al.* Epidemiology of Herpes Simplex Virus Type 2 in Canada, Australia, and New Zealand: Systematic Review, Meta-Analyses, and Meta-Regressions. Sex Transm Dis, 2022. 49: 403.
https://www.ncbi.nlm.nih.gov/pubmed/35608096
460. Magaret, A.S., *et al.* Effect of Condom Use on Per-act HSV-2 Transmission Risk in HIV-1, HSV-2-discordant Couples. Clin Infect Dis, 2016. 62: 456.
https://www.ncbi.nlm.nih.gov/pubmed/26578538
461. Hochberg, C.H., *et al.* Population and dyadic-based seroincidence of herpes simplex virus-2 and syphilis in southern India. Sex Transm Infect, 2015. 91: 375.
https://www.ncbi.nlm.nih.gov/pubmed/25605970
462. Sasso, B.M., *et al.* Herpes simplex virus mucocutaneous tumoural lesions - Systematic review. J Clin Virol, 2020. 123: 104246.
https://www.ncbi.nlm.nih.gov/pubmed/31927151
463. Johnston, C., *et al.* Highly conserved intragenic HSV-2 sequences: Results from next-generation sequencing of HSV-2 U(L) and U(S) regions from genital swabs collected from 3 continents. Virology, 2017. 510: 90.
https://www.ncbi.nlm.nih.gov/pubmed/28711653
464. Liu, J., *et al.* Development and evaluation of the quantitative real-time PCR assay in detection and typing of herpes simplex virus in swab specimens from patients with genital herpes. Int J Clin Exp Med, 2015. 8: 18758.
https://www.ncbi.nlm.nih.gov/pubmed/26770492
465. Young, S., *et al.* Multicenter evaluation of the Luminex® ARIES® HSV 1&2 Assay for the detection of herpes simplex virus types 1 and 2 in cutaneous and mucocutaneous lesion specimens. Expert Rev Mol Diagn, 2016. 16: 1241.
https://www.ncbi.nlm.nih.gov/pubmed/27771977
466. Schremser, V., *et al.* Polymerase chain reaction for the diagnosis of herpesvirus infections in dermatology : Analysis of clinical data. Wien Klin Wochenschr, 2020. 132: 35.
https://www.ncbi.nlm.nih.gov/pubmed/31820101
467. Binnicker, M.J., *et al.* Automated processing, extraction and detection of herpes simplex virus types 1 and 2: A comparative evaluation of three commercial platforms using clinical specimens. J Clin Virol, 2017. 89: 30.
https://www.ncbi.nlm.nih.gov/pubmed/28226272
468. Patwardhan, V., *et al.* A Comparative Analysis of Polymerase Chain Reaction and Direct Fluorescent Antibody Test for Diagnosis of Genital Herpes. J Lab Physicians, 2017. 9: 53.
https://www.ncbi.nlm.nih.gov/pubmed/28042218
469. Patel, E.U., *et al.* Precision of the Kalon Herpes Simplex Virus Type 2 IgG ELISA: an international inter-laboratory assessment. BMC Infect Dis, 2015. 15: 398.
https://www.ncbi.nlm.nih.gov/pubmed/26423888
470. Patwardhan, V., *et al.* Role of type-specific herpes simplex virus-1 and 2 serology as a diagnostic modality in patients with clinically suspected genital herpes: A comparative study in Indian population from a tertiary care hospital. Indian J Pathol Microbiol, 2016. 59: 318.
https://www.ncbi.nlm.nih.gov/pubmed/27510668
471. Liu, T., *et al.* Production of a fragment of glycoprotein G of herpes simplex virus type 2 and evaluation of its diagnostic potential. Singapore Med J, 2015. 56: 346.
https://www.ncbi.nlm.nih.gov/pubmed/25532518
472. Al-Shobaili, H., *et al.* Evaluation of the HerpeSelect Express rapid test in the detection of herpes simplex virus type 2 antibodies in patients with genital ulcer disease. J Clin Lab Anal, 2015. 29: 43.
https://www.ncbi.nlm.nih.gov/pubmed/24687953

473. Shevlin, E., *et al.* Comparative performance of the Uni-Gold™ HSV-2 Rapid: a point-of-care HSV-2 diagnostic test in unselected sera from a reference laboratory. J Clin Virol, 2014. 61: 378.
https://www.ncbi.nlm.nih.gov/pubmed/25200648
474. Wald, A., *et al.* Helicase-Primase Inhibitor Pritelivir for HSV-2 Infection. N Engl J Med, 2014. 370: 201.
https://pubmed.ncbi.nlm.nih.gov/24428466
475. Takada, A., *et al.* Statistical analysis of Amenamevir (ASP2151) between pharmacokinetics and clinical efficacies with non-linear effect model for the treatment of genital herpes. Clin Pharmacol Drug Dev, 2014. 3: 365.
https://www.ncbi.nlm.nih.gov/pubmed/27129009
476. Kawashima, M., *et al.* Single-Dose, Patient-Initiated Amenamevir Therapy for Recurrent Genital Herpes: A Phase 3, Randomized, Double-Blind, Placebo-Controlled Study. Open Forum Infect Dis, 2022. 9: ofac494.
https://www.ncbi.nlm.nih.gov/pubmed/36267254
477. You, Y., *et al.* Multicenter randomized study of inosine pranobex versus acyclovir in the treatment of recurrent herpes labialis and recurrent herpes genitalis in Chinese patients. J Dermatol, 2015. 42: 596.
https://www.ncbi.nlm.nih.gov/pubmed/25819042
478. Yi, T.J., *et al.* Valacyclovir therapy does not reverse herpes-associated alterations in cervical immunology: a randomized, placebo-controlled crossover trial. J Infect Dis, 2014. 210: 708.
https://www.ncbi.nlm.nih.gov/pubmed/24664172
479. Wald, A., *et al.* Effect of Pritelivir Compared With Valacyclovir on Genital HSV-2 Shedding in Patients With Frequent Recurrences: A Randomized Clinical Trial. JAMA, 2016. 316: 2495.
https://www.ncbi.nlm.nih.gov/pubmed/27997653
480. Mark, K.E., *et al.* Three phase III randomized controlled trials of topical resiquimod 0.01-percent gel to reduce anogenital herpes recurrences. Antimicrob Agents Chemother, 2014. 58: 5016.
https://www.ncbi.nlm.nih.gov/pubmed/24709264
481. Khemis, A., *et al.* Evaluation of the activity and safety of CS21 barrier genital gel® compared to topical aciclovir and placebo in symptoms of genital herpes recurrences: a randomized clinical trial. J Eur Acad Dermatol Venereol, 2014. 28: 1158.
https://www.ncbi.nlm.nih.gov/pubmed/24010876
482. Van Wagoner, N., *et al.* Effects of Different Doses of GEN-003, a Therapeutic Vaccine for Genital Herpes Simplex Virus-2, on Viral Shedding and Lesions: Results of a Randomized Placebo-Controlled Trial. J Infect Dis, 2018. 218: 1890.
https://www.ncbi.nlm.nih.gov/pubmed/29982727
483. Flechtner, J.B., *et al.* Immune responses elicited by the GEN-003 candidate HSV-2 therapeutic vaccine in a randomized controlled dose-ranging phase 1/2a trial. Vaccine, 2016. 34: 5314.
https://www.ncbi.nlm.nih.gov/pubmed/27642130
484. Bernstein, D.I., *et al.* Therapeutic Vaccine for Genital Herpes Simplex Virus-2 Infection: Findings From a Randomized Trial. J Infect Dis, 2017. 215: 856.
https://www.ncbi.nlm.nih.gov/pubmed/28329211
485. Bernstein, D.I., *et al.* Therapeutic HSV-2 vaccine decreases recurrent virus shedding and recurrent genital herpes disease. Vaccine, 2019. 37: 3443.
https://www.ncbi.nlm.nih.gov/pubmed/31103365
486. Dropulic, L.K., *et al.* A Randomized, Double-Blinded, Placebo-Controlled, Phase 1 Study of a Replication-Defective Herpes Simplex Virus (HSV) Type 2 Vaccine, HSV529, in Adults With or Without HSV Infection. J Infect Dis, 2019. 220: 990.
https://www.ncbi.nlm.nih.gov/pubmed/31058977
487. Chandra, J., *et al.* Immune responses to a HSV-2 polynucleotide immunotherapy COR-1 in HSV-2 positive subjects: A randomized double blinded phase I/IIa trial. PLoS One, 2019. 14: e0226320.
https://www.ncbi.nlm.nih.gov/pubmed/31846475
488. Grabowski, M.K., *et al.* Herpes Simplex [corrected] Virus Type 2 Shedding From Male Circumcision Wounds in Rakai, Uganda. J Infect Dis, 2015. 212: 1613.
https://www.ncbi.nlm.nih.gov/pubmed/25943201
489. Osiecka, B.J., *et al.* Photodynamic Therapy with Red Light and 5-Aminolaevulinic Acid for Herpes Simplex Recurrence: Preliminary Results. Acta Derm Venereol, 2017. 97: 1239.
https://www.ncbi.nlm.nih.gov/pubmed/28681068
490. Vallely, A.J., *et al.* Dorsal longitudinal foreskin cut is associated with reduced risk of HIV, syphilis and genital herpes in men: a cross-sectional study in Papua New Guinea. J Int AIDS Soc, 2017. 20: 21358.
https://www.ncbi.nlm.nih.gov/pubmed/28406272
491. Abdool Karim, S.S., *et al.* Tenofovir Gel for the Prevention of Herpes Simplex Virus Type 2 Infection. N Engl J Med, 2015. 373: 530.
https://www.ncbi.nlm.nih.gov/pubmed/26244306

492. European Center for Disease Pervention and Control/World Health Organisation. Tuberculosis surveillance and monitoring in Europe 2021 (2019 data). ECDC/WHO. ISBN 978-92-9498-534-7. https://www.ecdc.europa.eu/sites/default/files/documents/tuberculosis-surveillance-monitoring-Europe-2021.pdf
493. Hayward, S.E., *et al.* Extrapulmonary tuberculosis among migrants in Europe, 1995 to 2017. Clin Microbiol Infect, 2021. 27: 1347 e1. https://www.ncbi.nlm.nih.gov/pubmed/33352301
494. Lawn, S.D., *et al.* Tuberculosis. Lancet, 2011. 378: 57. https://www.ncbi.nlm.nih.gov/pubmed/21420161
495. Kang, W., *et al.* Epidemiology of concurrent extrapulmonary tuberculosis in inpatients with extrapulmonary tuberculosis lesions in China: a large-scale observational multi-centre investigation. Int J Infect Dis, 2022. 115: 79. https://www.ncbi.nlm.nih.gov/pubmed/34781005
496. Vynnycky, E., *et al.* The natural history of tuberculosis: the implications of age-dependent risks of disease and the role of reinfection. Epidemiol Infect, 1997. 119: 183. https://www.ncbi.nlm.nih.gov/pubmed/9363017
497. World Health Organization. WHO consolidated guidelines on tuberculosis. Module 1: prevention - tuberculosis preventive treatment. ISBN 978-92-4-000150-3, 2020. https://www.who.int/publications/i/item/9789240001503
498. Lewinsohn, D.M., *et al.* Official American Thoracic Society/Infectious Diseases Society of America/Centers for Disease Control and Prevention Clinical Practice Guidelines: Diagnosis of Tuberculosis in Adults and Children. Clin Infect Dis, 2017. 64: 111. https://www.ncbi.nlm.nih.gov/pubmed/28052967
499. European Centre for Disease Prevention and Control. Mastering the basics of TB control: Development of a handbook on TB diagnostic methods. Stockholm, ECDC, 2011. ISBN 978-92-9193-242-9. https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/1105_TER_Basics_TB_control.pdf
500. Ye, Y., *et al.* Clinical Features and Drug-Resistance Profile of Urinary Tuberculosis in South-Western China: A Cross-sectional Study. Medicine (Baltimore), 2016. 95: e3537. https://www.ncbi.nlm.nih.gov/pubmed/27175652
501. Pingle, P., *et al.* Evaluation of Microscopy, Culture and PCR Methods in the Laboratory Diagnosis of Genito-urinary Tuberculosis. American Journal of Infectious Diseases and Microbiology, 2014. 2: 17. http://pubs.sciepub.com/ajidm/2/1/4
502. Sun, L., *et al.* Rapid diagnosis in early stage renal tuberculosis by real-time polymerase chain reaction on renal biopsy specimens. Int J Tuberc Lung Dis, 2010. 14: 341. https://www.ncbi.nlm.nih.gov/pubmed/20132626
503. Kumar, P., *et al.* Diagnosis of renal tuberculosis by real-time polymerase chain reaction in renal biopsy sample. World Journal of Pharmaceutical and Medical Research, 2017. 3: 285. https://www.wjpmr.com/download/article/25082017/1504230975.pdf
504. World Health Organization. WHO consolidated guidelines on tuberculosis. Module 3: diagnosis - rapid diagnostics for tuberculosis detection 2021 update. ISBN 978-92-4-002941-5 2021. https://www.who.int/publications/i/item/9789240029415
505. World Health Organization. WHO consolidated guidelines on tuberculosis. Module 3: diagnosis - rapid diagnostics for tuberculosis detection. Web Annex 4. Evidence synthesis and analysis. ISBN 978-92-4-001026-0, 2020. https://iris.who.int/items/e0a34fe0-84b3-4e35-b66a-77c62fc92987
506. Hemal, A.K., *et al.* Polymerase chain reaction in clinically suspected genitourinary tuberculosis: comparison with intravenous urography, bladder biopsy, and urine acid fast bacilli culture. Urology, 2000. 56: 570. https://www.ncbi.nlm.nih.gov/pubmed/11018606
507. Muttarak, M., *et al.* Tuberculous epididymitis and epididymo-orchitis: sonographic appearances. AJR Am J Roentgenol, 2001. 176: 1459. https://www.ncbi.nlm.nih.gov/pubmed/11373214
508. Yang, D.M., *et al.* Differential diagnosis of focal epididymal lesions with gray scale sonographic, color Doppler sonographic, and clinical features. J Ultrasound Med, 2003. 22: 135. https://www.ncbi.nlm.nih.gov/pubmed/12562118
509. Li, S., *et al.* A better understanding of testicular and/or epididymal tuberculosis based on clinical, ultrasonic, computed tomography, and magnetic resonance imaging features at a high-volume institute in the modern era. Quant Imaging Med Surg, 2021. 11: 2465. https://www.ncbi.nlm.nih.gov/pubmed/34079716
510. Jing, J., *et al.* Vas deferens sonographic appearances of tuberculosis lesions of 19 cases of male genital systemic tuberculosis. Medicine (Baltimore), 2019. 98: e14843. https://www.ncbi.nlm.nih.gov/pubmed/30882677

511. Yang, D.M., *et al.* Chronic tuberculous epididymitis: color Doppler US findings with histopathologic correlation. Abdom Imaging, 2000. 25: 559.
https://www.ncbi.nlm.nih.gov/pubmed/10931999
512. Rui, X., *et al.* Ultrasonographic diagnosis and typing of renal tuberculosis. Int J Urol, 2008. 15: 135.
https://www.ncbi.nlm.nih.gov/pubmed/18269447
513. Radwan, A., *et al.* Multimodality Imaging of Genitourinary Tuberculosis. Curr Probl Diagn Radiol, 2021. 50: 867.
https://www.ncbi.nlm.nih.gov/pubmed/33272721
514. Baumgarten, D.A., *et al.* Imaging and radiologic management of upper urinary tract infections. Urol Clin North Am, 1997. 24: 545.
https://www.ncbi.nlm.nih.gov/pubmed/9275978
515. Muttarak, M., *et al.* Tuberculosis of the genitourinary tract: imaging features with pathological correlation. Singapore Med J, 2005. 46: 568.
https://www.ncbi.nlm.nih.gov/pubmed/16172781
516. Wang, Y., *et al.* Computerised tomography and intravenous pyelography in urinary tuberculosis: a retrospective descriptive study. Int J Tuberc Lung Dis, 2015. 19: 1441.
https://www.ncbi.nlm.nih.gov/pubmed/26614184
517. Sataa, S., *et al.* Imaging findings of urinary tuberculosis on computerized tomography versus excretory urography: Through 46 confirmed cases. Tunisie Medicale, 2014. 92: 743.
https://www.ncbi.nlm.nih.gov/pubmed/25879600
518. Wang, L.J., *et al.* Imaging findings of urinary tuberculosis on excretory urography and computerized tomography. J Urol, 2003. 169: 524.
https://www.ncbi.nlm.nih.gov/pubmed/12544301
519. Birnbaum, B.A., *et al.* Extrarenal genitourinary tuberculosis: CT appearance of calcified pipe-stem ureter and seminal vesicle abscess. J Comput Assist Tomogr, 1990. 14: 653.
https://www.ncbi.nlm.nih.gov/pubmed/2370364
520. Jung, Y.Y., *et al.* Genitourinary tuberculosis: comprehensive cross-sectional imaging. AJR Am J Roentgenol, 2005. 184: 143.
https://www.ncbi.nlm.nih.gov/pubmed/15615965
521. Wang, L.J., *et al.* CT features of genitourinary tuberculosis. J Comput Assist Tomogr, 1997. 21: 254.
https://www.ncbi.nlm.nih.gov/pubmed/9071295
522. Sharma, J.B., *et al.* Female genital tuberculosis: Revisited. Indian J Med Res, 2018. 148: S71.
https://www.ncbi.nlm.nih.gov/pubmed/30964083
523. Mantica, G., *et al.* Genitourinary Tuberculosis: A Comprehensive Review of a Neglected Manifestation in Low-Endemic Countries. Antibiotics (Basel), 2021. 10.
https://www.ncbi.nlm.nih.gov/pubmed/34827337
524. da Rocha, E.L., *et al.* Abdominal tuberculosis: a radiological review with emphasis on computed tomography and magnetic resonance imaging findings. Radiol Bras, 2015. 48: 181.
https://www.ncbi.nlm.nih.gov/pubmed/26185345
525. Cheng, Y., *et al.* Multiparametric Magnetic Resonance Imaging Characteristics of Prostate Tuberculosis. Korean J Radiol, 2015. 16: 846.
https://www.ncbi.nlm.nih.gov/pubmed/26175584
526. Ahmadi, F., *et al.* Hysterosalpingographic Appearances of Female Genital Tract Tuberculosis: Part II: Uterus. Int J Fertil Steril, 2014. 8: 13.
https://www.ncbi.nlm.nih.gov/pubmed/24696765
527. Ahmadi, F., *et al.* Hysterosalpingographic appearances of female genital tract tuberculosis: part I. Fallopian tube. Int J Fertil Steril, 2014. 7: 245.
https://www.ncbi.nlm.nih.gov/pubmed/24520493
528. Netter, A., *et al.* [Tuberculous endo-uterine symphysis; an anatomo-clinical and radiologically characteristic syndrome]. Gynecol Obstet (Paris), 1955. 54: 19.
https://www.ncbi.nlm.nih.gov/pubmed/14391756
529. World Health Organization. WHO consolidated guidelines on tuberculosis Module 4: Treatment: Drug-susceptible tuberculosis treatment 2022. ISBN 978-92-4-004812-6.
https://www.who.int/publications/i/item/9789240048126
530. European Centre for Disease Pervention and Control. European Union Standards for Tuberculosis Care 2017 update. ISBN 978-92-9498-247-6.
https://www.ecdc.europa.eu/en/publications-data/european-union-standards-tuberculosis-care-2017-update
531. Huang, Y., *et al.* Surgical management of tuberculous epididymo-orchitis: a retrospective study of 81 cases with long-term follow-up. BMC Infect Dis, 2021. 21: 1068.
https://www.ncbi.nlm.nih.gov/pubmed/34654377

532. Mittal, A., *et al.* Surgical Management of Genitourinary Tuberculosis: our Experience and review of literature. Pol Przegl Chir, 2020. 92: 1.
https://www.ncbi.nlm.nih.gov/pubmed/33408264
533. Figueiredo, A.A., *et al.* Epidemiology of urogenital tuberculosis worldwide. Int J Urol, 2008. 15: 827.
https://www.ncbi.nlm.nih.gov/pubmed/18637157
534. Mochalova, T.P., *et al.* Reconstructive surgery for treatment of urogenital tuberculosis: 30 years of observation. World J Surg, 1997. 21: 511.
https://www.ncbi.nlm.nih.gov/pubmed/9204739
535. Gupta, N.P., *et al.* Reconstructive surgery for the management of genitourinary tuberculosis: a single center experience. J Urol, 2006. 175: 2150.
https://www.ncbi.nlm.nih.gov/pubmed/16697825
536. Kumar, A., *et al.* Can kidneys be saved in patients with urinary tuberculosis? A study in the era of modern chemotherapy and surgical armamentarium. Int J Urol, 2019. 26: 551.
https://www.ncbi.nlm.nih.gov/pubmed/30803052
537. Pal, D.K., *et al.* Role of surgical intervention in genitourinary tuberculosis in the era of modern anti-tubercular chemotherapy. Sch. J. App. Med. Sci, 2015. 3: 1608.
https://www.researchgate.net/publication/279925411
538. Li, X., *et al.* A Clinical Comparative Analysis of Retroperitoneal Laparoscopic Tuberculous Nephrectomy and Open Tuberculous Nephrectomy. J Laparoendosc Adv Surg Tech A, 2019. 29: 909.
https://www.ncbi.nlm.nih.gov/pubmed/30932738
539. Zhang, S., *et al.* Open surgery versus retroperitoneal laparoscopic nephrectomy for renal tuberculosis: a retrospective study of 120 patients. PeerJ, 2016. 4: e2708.
https://www.ncbi.nlm.nih.gov/pubmed/27917313
540. Kim, H.H., *et al.* Laparoscopic nephrectomy for nonfunctioning tuberculous kidney. J Endourol, 2000. 14: 433.
https://www.ncbi.nlm.nih.gov/pubmed/10958566
541. Han, W.K., *et al.* The feasibility of laparoendoscopic single-site nephrectomy: initial experience using home-made single-port device. Urology, 2010. 76: 862.
https://www.ncbi.nlm.nih.gov/pubmed/20110116
542. Hemal, A.K., *et al.* Comparison of retroperitoneoscopic nephrectomy with open surgery for tuberculous nonfunctioning kidneys. J Urol, 2000. 164: 32.
https://www.ncbi.nlm.nih.gov/pubmed/10840418
543. Kauffman, C.A., *et al.* Prospective multicenter surveillance study of funguria in hospitalized patients. The National Institute for Allergy and Infectious Diseases (NIAID) Mycoses Study Group. Clin Infect Dis, 2000. 30: 14.
https://www.ncbi.nlm.nih.gov/pubmed/10619726
544. Ahmadikia, K., *et al.* Increased urine Interleukin-17 and Interleukin-22 levels in patients with candidal urinary tract infection. Iran J Kidney Dis, 2018. 12: 33EP.
https://pubmed.ncbi.nlm.nih.gov/29421775
545. Fisher, J.F. Candida urinary tract infections--epidemiology, pathogenesis, diagnosis, and treatment: executive summary. Clin Infect Dis, 2011. 52 Suppl 6: S429.
https://www.ncbi.nlm.nih.gov/pubmed/21498835
546. Konje, E.T., *et al.* Five-year cross-sectional study to determine the burden of Candida spp. infections of the urinary tract system among patients attending tertiary hospital in Northwestern Tanzania. BMJ open, 2023. 13: e074833.
https://pubmed.ncbi.nlm.nih.gov/38154909
547. Bouza, E., *et al.* A European perspective on nosocomial urinary tract infections I. Report on the microbiology workload, etiology and antimicrobial susceptibility (ESGNI-003 study). European Study Group on Nosocomial Infections. Clin Microbiol Infect, 2001. 7: 523.
https://www.ncbi.nlm.nih.gov/pubmed/11683792
548. Alvarez-Lerma, F., *et al.* Candiduria in critically ill patients admitted to intensive care medical units. Intensive Care Med, 2003. 29: 1069.
https://www.ncbi.nlm.nih.gov/pubmed/12756441
549. Alvarez-Lerma, F., *et al.* [Fungal colonization and/or infection in intensive care units. Multicenter study of 1,562 patients]. Med Clin (Barc), 2003. 121: 161.
https://www.ncbi.nlm.nih.gov/pubmed/12867000
550. Kumar, R., *et al.* Prevalence of Candida species in Urinary Tract Infections from a Tertiary Care Hospital Prospective study. International Journal of Life Sciences Biotechnology and Pharma Research, 2024. 13: 671.
https://ijlbpr.com/uploadfiles/122vol13issue3pp671-672.20240716063122.pdf
551. Centers for Disease Control and Prevention. About C. auris. 2024.
https://www.cdc.gov/candida-auris/about/index.html
552. Chowdhary, A., *et al.* Candida auris Genetics and Emergence. Annu Rev Microbiol, 2023. 77: 583.
https://www.ncbi.nlm.nih.gov/pubmed/37406342

553. Griffith, N., *et al.* Candida auris Urinary Tract Infections and Possible Treatment. Antibiotics (Basel), 2020. 9.
https://www.ncbi.nlm.nih.gov/pubmed/33322761
554. Krcmery, S., *et al.* Fungal urinary tract infections in patients at risk. International journal of antimicrobial agents, 1999. 11: 289.
https://www.ncbi.nlm.nih.gov/pubmed/10394985
555. Kamani, L., *et al.* Fungal urinary tract infection among chronic liver disease patients with hepatic encephalopathy and its treatment outcomes. JGH Open, 2021. 5: 213.
https://pubmed.ncbi.nlm.nih.gov/33553658
556. Rashwan, N.M., *et al.* Pattern of candida urinary tract infections among cancer patients in South Egypt Cancer Institute. Bulletin of Pharmaceutical Sciences, 2010. 33: 121.
https://bpsa.journals.ekb.eg/article_147033.html
557. Sarwar, F., *et al.* Fungal Urinary Tract Infection; A Study Conducted on Patients with Liver Cirrhosis. Pakistan Journal of Medical and Health Sciences, 2021. 15: 3129.
http://pjmhsonline.com/published-issues/2021/november/113129
558. Chen, L.F., *et al.* Hospital-acquired urinary tract infections in patients with diabetes and urinary catheterization. Journal of Experimental and Clinical Medicine (Taiwan), 2014. 6: 90.
https://hub.tmu.edu.tw/en/publications/hospital-acquired-urinary-tract-infections-in-patients-with-diabe/
559. Deorukhkar, S.C., *et al.* Medical Device-Associated Candida Infections in a Rural Tertiary Care Teaching Hospital of India. Interdiscip Perspect Infect Dis, 2016. 2016: 1854673.
https://pubmed.ncbi.nlm.nih.gov/26904115
560. Karthikeya, P., *et al.* Urinary Tract Infections In Catheterized Patients And Antibiotic Sensitivity Patterns. European Journal of Molecular and Clinical Medicine, 2022. 9: 1200.
https://www.ejmcm.com/archives/volume-9/issue-1/1161
561. Clifford, T.G., *et al.* Urinary tract infections following radical cystectomy and urinary diversion: a review of 1133 patients. World J Urol, 2018. 36: 775.
https://pubmed.ncbi.nlm.nih.gov/29372354
562. Lu, X., *et al.* Early Warning Models to Predict the 90-Day Urinary Tract Infection Risk After Radical Cystectomy and Urinary Diversion for Patients With Bladder Cancer. Front Surg, 2021. 8: 782029.
https://pubmed.ncbi.nlm.nih.gov/35127802
563. Jensen, J.U., *et al.* Invasive Candida infections and the harm from antibacterial drugs in critically ill patients: data from a randomized, controlled trial to determine the role of ciprofloxacin, piperacillin-tazobactam, meropenem, and cefuroxime. Crit Care Med, 2015. 43: 594.
https://www.ncbi.nlm.nih.gov/pubmed/25493970
564. Kauffman, C.A. Candiduria. Clin Infect Dis, 2005. 41 Suppl 6: S371.
https://www.ncbi.nlm.nih.gov/pubmed/16108001
565. Kauffman, C.A., *et al.* Candida urinary tract infections--diagnosis. Clin Infect Dis, 2011. 52 Suppl 6: S452.
https://www.ncbi.nlm.nih.gov/pubmed/21498838
566. de Freitas, A.R., *et al.* Yeasts isolated from nosocomial urinary infections: Antifungal susceptibility and biofilm production. Rev Iberoam Micol, 2014. 31: 104EP.
https://pubmed.ncbi.nlm.nih.gov/23810785
567. Kauffman, C.A. Diagnosis and management of fungal urinary tract infection. Infect Dis Clin North Am, 2014. 28: 61.
https://www.ncbi.nlm.nih.gov/pubmed/24484575
568. Jacobs, L.G., *et al.* Oral fluconazole compared with bladder irrigation with amphotericin B for treatment of fungal urinary tract infections in elderly patients. Clin Infect Dis, 1996. 22: 30.
https://pubmed.ncbi.nlm.nih.gov/8824962
569. Jacobs, L.G., *et al.* Bladder irrigation with amphotericin B for treatment of fungal urinary tract infections. Clin Infect Dis, 1994. 18: 313.
https://pubmed.ncbi.nlm.nih.gov/8011810
570. Gabardi, S., *et al.* Micafungin treatment and eradication of candiduria among hospitalized patients. Int Urol Nephrol, 2016. 48: 1881.
https://pubmed.ncbi.nlm.nih.gov/27587066
571. de Vasconcelos, A.A., Jr., *et al.* Chromogenic medium for direct susceptibility testing of Candida spp. isolated from urine. Mycopathologia, 2011. 172: 125.
https://www.ncbi.nlm.nih.gov/pubmed/21369747
572. Nicolle, L.E. A practical guide to antimicrobial management of complicated urinary tract infection. Drugs Aging, 2001. 18: 243.
https://www.ncbi.nlm.nih.gov/pubmed/11341472
573. Wise, G.J. Genitourinary fungal infections: a therapeutic conundrum. Expert Opin Pharmacother, 2001. 2: 1211.
https://www.ncbi.nlm.nih.gov/pubmed/11584989

574. Sadegi, B.J., *et al.* Primary renal candidiasis: importance of imaging and clinical history in diagnosis and management. J Ultrasound Med, 2009. 28: 507.
https://www.ncbi.nlm.nih.gov/pubmed/19321678
575. Erden, A., *et al.* Radiological findings in the diagnosis of genitourinary candidiasis. Pediatr Radiol, 2000. 30: 875.
https://www.ncbi.nlm.nih.gov/pubmed/11149100
576. Pappas, P.G., *et al.* Clinical Practice Guideline for the Management of Candidiasis: 2016 Update by the Infectious Diseases Society of America. Clin Infect Dis, 2016. 62: e1.
https://www.ncbi.nlm.nih.gov/pubmed/26679628
577. Sobel, J.D., *et al.* Candiduria: a randomized, double-blind study of treatment with fluconazole and placebo. The National Institute of Allergy and Infectious Diseases (NIAID) Mycoses Study Group. Clin Infect Dis, 2000. 30: 19.
https://www.ncbi.nlm.nih.gov/pubmed/10619727
578. Potasman, I., *et al.* Oral fluconazole for Candida urinary tract infection. Urol Int, 1997. 59: 252.
https://pubmed.ncbi.nlm.nih.gov/9444745
579. Bell, D.A., *et al.* Percutaneous nephrostomy for nonoperative management of fungal urinary tract infections. Journal of vascular and interventional radiology : JVIR, 1993. 4: 311.
https://www.ncbi.nlm.nih.gov/pubmed/8481584
580. Wise, G.J., *et al.* Flucytosine in urinary candida infections. Urology, 1974. 3: 708EP.
https://www.goldjournal.net/article/S0090-4295(74)80209-8/abstract
581. Fan, X., *et al.* High prevalence of fluconazole resistant Candida tropicalis among candiduria samples in China: An ignored matter of concern. Front Microbiol, 2023. 14: 1125241.
https://www.ncbi.nlm.nih.gov/pubmed/36937265
582. Sobel, J.D., *et al.* Caspofungin in the treatment of symptomatic candiduria. Clin Infect Dis, 2007. 44: e46.
https://www.ncbi.nlm.nih.gov/pubmed/17278048
583. Rkieh, L., *et al.* Outcomes of caspofungin use in the treatment of Candida-related urinary tract infections, a case series. IDCases, 2022. 28: e01510.
https://pubmed.ncbi.nlm.nih.gov/35646592
584. Grau, S., *et al.* Urinary micafungin levels are sufficient to treat urinary tract infections caused by Candida spp. Int J Antimicrob Agents, 2016. 48: 212.
https://www.ncbi.nlm.nih.gov/pubmed/27424599
585. Govel, J.C., *et al.* Evaluation of shorter versus longer antifungal treatment durations for Candida spp. urinary tract infections among hospitalized adults. Antimicrob Agents Chemother, 2025. 69: e0192024.
https://pubmed.ncbi.nlm.nih.gov/40261002
586. Graybill, J.R., *et al.* Ketoconazole therapy for fungal urinary tract infections. J Urol, 1983. 129: 68EP.
https://pubmed.ncbi.nlm.nih.gov/6298476
587. Boglione-Kerrien, C., *et al.* Voriconazole as an alternative oral treatment in fluconazole-resistant urinary candidiasis. Infect Dis Now, 2024. 54: 104955.
https://pubmed.ncbi.nlm.nih.gov/39043250
588. Zeitoun, H., *et al.* Elucidation of the mechanisms of fluconazole resistance and repurposing treatment options against urinary Candida spp. isolated from hospitalized patients in Alexandria, Egypt. BMC Microbiol, 2024. 24: 383.
https://pubmed.ncbi.nlm.nih.gov/39354378
589. Tuon, F.F., *et al.* Bladder irrigation with amphotericin B and fungal urinary tract infection--systematic review with meta-analysis. Int J Infect Dis, 2009. 13: 701.
https://www.ncbi.nlm.nih.gov/pubmed/19155184
590. Puckrin, R., *et al.* SGLT-2 inhibitors and the risk of infections: a systematic review and meta-analysis of randomized controlled trials. Acta Diabetol, 2018. 55: 503.
https://www.ncbi.nlm.nih.gov/pubmed/29484489
591. Ren, J., *et al.* Sodium-glucose cotransporter 2 inhibitor increases risk of urinary tract infection: Evidence from mendelian randomization and meta-analysis. Br J Clin Pharmacol, 2025. 91: 2621.
https://www.ncbi.nlm.nih.gov/pubmed/40289746
592. Li, D., *et al.* Urinary tract and genital infections in patients with type 2 diabetes treated with sodium-glucose co-transporter 2 inhibitors: A meta-analysis of randomized controlled trials. Diabetes Obes Metab, 2017. 19: 348.
https://www.ncbi.nlm.nih.gov/pubmed/27862830
593. Guo, M., *et al.* The efficacy and safety of combinations of SGLT2 inhibitors and GLP-1 receptor agonists in the treatment of type 2 diabetes or obese adults: a systematic review and meta-analysis. Endocrine, 2020. 67: 294.
https://pubmed.ncbi.nlm.nih.gov/31900793
594. Lega, I.C., *et al.* Sodium glucose cotransporter 2 inhibitors and risk of genital mycotic and urinary tract infection: A population-based study of older women and men with diabetes. Diabetes, Obesity and Metabolism, 2019. 21: 2394.
https://pubmed.ncbi.nlm.nih.gov/31264755/

595. Chan, G.C.K., *et al.* SGLT2 inhibitors reduce adverse kidney and cardiovascular events in patients with advanced diabetic kidney disease: A population-based propensity score-matched cohort study. Diabetes Res Clin Pract, 2023. 195: 110200.
https://pubmed.ncbi.nlm.nih.gov/36481225
596. Xu, J., *et al.* Risk of Urinary Tract Infections with Sodium-Glucose Transport Protein-2 Inhibitors in Subpopulations with Abnormal Genitourinary Pathology. Clin J Am Soc Nephrol, 2025. 20: 820EP.
https://pubmed.ncbi.nlm.nih.gov/40215113
597. European Centre for Disease Prevention and Control. Annual Epidemiological Report 2016 - Healthcare-associated infections acquired in intensive care units. 2016.
https://www.ecdc.europa.eu/en/publications-data/healthcare-associated-infections-intensive-care-units-annual-epidemiological-0
598. Control, C.f.D. Procedure-associated Module 9: Surgical Site Infection (SSI) Event. . 2017.
https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf
599. Tanner, J., *et al.* Surgical hand antisepsis to reduce surgical site infection. Cochrane Database Syst Rev, 2016. 2016: CD004288.
https://www.ncbi.nlm.nih.gov/pubmed/26799160
600. Webster, J., *et al.* Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. Cochrane Database Syst Rev, 2015. 2015: CD004985.
https://www.ncbi.nlm.nih.gov/pubmed/25927093
601. Tanner, J., *et al.* Preoperative hair removal to reduce surgical site infection. Cochrane Database Syst Rev, 2011: CD004122.
https://www.ncbi.nlm.nih.gov/pubmed/22071812
602. Arnold, A., *et al.* Preoperative Mechanical Bowel Preparation for Abdominal, Laparoscopic, and Vaginal Surgery: A Systematic Review. J Minim Invasive Gynecol, 2015. 22: 737.
https://www.ncbi.nlm.nih.gov/pubmed/25881881
603. Guenaga, K.F., *et al.* Mechanical bowel preparation for elective colorectal surgery. Cochrane Database Syst Rev, 2011. 2011: CD001544.
https://www.ncbi.nlm.nih.gov/pubmed/21901677
604. Dumville, J.C., *et al.* Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. Cochrane Database Syst Rev, 2015. 2015: CD003949.
https://www.ncbi.nlm.nih.gov/pubmed/25897764
605. Webster, J., *et al.* Use of plastic adhesive drapes during surgery for preventing surgical site infection. Cochrane Database Syst Rev, 2015. 2015: CD006353.
https://www.ncbi.nlm.nih.gov/pubmed/25901509
606. Bonkat, G., *et al.* Non-molecular Methods to Detect Bacteriuria Prior to Urological Interventions: A Diagnostic Accuracy Systematic Review. Eur Urol Focus, 2017. 3: 535.
https://www.ncbi.nlm.nih.gov/pubmed/29627196
607. European Centre for Disease Prevention and Control. Systematic review and evidence-based guidance on perioperative antibiotic prophylaxis. 2013.
https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/Perioperative%20antibiotic%20prophylaxis%20-%20June%202013.pdf
608. Antibacterial prophylaxis in surgery. Drug and Therapeutics Bulletin, 2004. 42: 9.
https://dtb.bmj.com/content/42/2/9.2
609. Benseler, A., *et al.* Antibiotic prophylaxis for urodynamic testing in women: a systematic review. Int Urogynecol J, 2021. 32: 27.
https://www.ncbi.nlm.nih.gov/pubmed/32845398
610. Foon, R., *et al.* Prophylactic antibiotics to reduce the risk of urinary tract infections after urodynamic studies [Systematic Review]. Cochrane Database of Systematic Reviews, 2012. 10: 10.
https://pubmed.ncbi.nlm.nih.gov/23076941/
611. Carey, M.M., *et al.* Should We Use Antibiotic Prophylaxis for Flexible Cystoscopy? A Systematic Review and Meta-Analysis. Urol Int, 2015. 95: 249.
https://www.ncbi.nlm.nih.gov/pubmed/26138144
612. Garcia-Perdomo, H.A., *et al.* Efficacy of antibiotic prophylaxis in cystoscopy to prevent urinary tract infection: a systematic review and meta-analysis. Int Braz J Urol, 2015. 41: 412.
https://www.ncbi.nlm.nih.gov/pubmed/26200530
613. Zeng, S., *et al.* Antimicrobial agents for preventing urinary tract infections in adults undergoing cystoscopy. Cochrane Database Syst Rev, 2019. 2: CD012305.
https://www.ncbi.nlm.nih.gov/pubmed/30789676

614. Bradshaw, A.W., *et al.* Antibiotics are not necessary during routine cystoscopic stent removal: A randomized controlled trial at UC San Diego. Urol Ann, 2020. 12: 373.
https://www.ncbi.nlm.nih.gov/pubmed/33776335
615. Lu, Y., *et al.* Antibiotic prophylaxis for shock wave lithotripsy in patients with sterile urine before treatment may be unnecessary: a systematic review and meta-analysis. J Urol, 2012. 188: 441.
https://www.ncbi.nlm.nih.gov/pubmed/22704118
616. Mrkobrada, M., *et al.* CUA Guidelines on antibiotic prophylaxis for urologic procedures. Can Urol Assoc J, 2015. 9: 13.
https://www.ncbi.nlm.nih.gov/pubmed/25737749
617. Hsieh, C.H., *et al.* The Effectiveness of Prophylactic Antibiotics with Oral Levofloxacin against Post-Shock Wave Lithotripsy Infectious Complications: A Randomized Controlled Trial. Surg Infect (Larchmt), 2016. 17: 346.
https://www.ncbi.nlm.nih.gov/pubmed/26910613
618. Shafi, H., *et al.* Antibiotic prophylaxis in the prevention of urinary tract infection in patients with sterile urine before extracorporeal shock wave lithotripsy. Caspian J Intern Med, 2018. 9: 296.
https://www.ncbi.nlm.nih.gov/pubmed/30197776
619. Lin, H.Y., *et al.* Atomoxetine Treatment Strengthens an Anti-Correlated Relationship between Functional Brain Networks in Medication-Naive Adults with Attention-Deficit Hyperactivity Disorder: A Randomized Double-Blind Placebo-Controlled Clinical Trial. Int J Neuropsychopharmacol, 2015. 19: pyv094.
https://www.ncbi.nlm.nih.gov/pubmed/26377368
620. Tikkinen, K.A.O., *et al.* A Multicenter Randomized Controlled Trial of Antimicrobial Prophylaxis to Prevent Urinary Tract Infections after Shockwave Lithotripsy for Urolithiasis: The APPEAL Trial. Eur Urol, 2025. 88: 543.
https://www.ncbi.nlm.nih.gov/pubmed/40998628
621. Deng, T., *et al.* Antibiotic prophylaxis in ureteroscopic lithotripsy: a systematic review and meta-analysis of comparative studies. BJU Int, 2018. 122: 29.
https://www.ncbi.nlm.nih.gov/pubmed/29232047
622. Zhao, Z., *et al.* Recommended antibiotic prophylaxis regimen in retrograde intrarenal surgery: evidence from a randomised controlled trial. BJU Int, 2019. 124: 496.
https://www.ncbi.nlm.nih.gov/pubmed/31136070
623. Qiao, L.D., *et al.* Evaluation of perioperative prophylaxis with fosfomycin tromethamine in ureteroscopic stone removal: an investigator-driven prospective, multicenter, randomized, controlled study. Int Urol Nephrol, 2018. 50: 427.
https://www.ncbi.nlm.nih.gov/pubmed/29290000
624. Yu, J., *et al.* Antibiotic prophylaxis in perioperative period of percutaneous nephrolithotomy: a systematic review and meta-analysis of comparative studies. World J Urol, 2020. 38: 1685.
https://www.ncbi.nlm.nih.gov/pubmed/31562533
625. Seyrek, M., *et al.* Perioperative prophylaxis for percutaneous nephrolithotomy: randomized study concerning the drug and dosage. J Endourol, 2012. 26: 1431.
https://www.ncbi.nlm.nih.gov/pubmed/22612061
626. Tuzel, E., *et al.* Prospective comparative study of two protocols of antibiotic prophylaxis in percutaneous nephrolithotomy. J Endourol, 2013. 27: 172.
https://www.ncbi.nlm.nih.gov/pubmed/22908891
627. Omar, M., *et al.* Ciprofloxacin infusion versus third generation cephalosporin as a surgical prophylaxis for percutaneous nephrolithotomy: a randomized study. Cent European J Urol, 2019. 72: 57.
https://www.ncbi.nlm.nih.gov/pubmed/31011442
628. Taken, K., *et al.* Comparison of Ceftriaxone and Cefazolin Sodium Antibiotic Prophylaxis in Terms of SIRS/Urosepsis Rates in Patients Undergoing Percutaneous Nephrolithotomy. J Urol Surg, 2019. 6: 111.
https://jurolsurgery.org/articles/comparison-of-ceftriaxone-and-cefazolin-sodium-antibiotic-prophylaxis-in-terms-of-sirsurosepsis-rates-in-patients-undergoing-percutaneous-nephrolithotomy/doi/jus.galenos.2018.2367
629. Dahm, P., *et al.* Evidence-based Urology. BMJ Books London, 2010: 50.
630. Bausch, K., *et al.* Antimicrobial Prophylaxis for Postoperative Urinary Tract Infections in Transurethral Resection of Bladder Tumors: A Systematic Review and Meta-Analysis. J Urol, 2021. 205: 987.
https://www.ncbi.nlm.nih.gov/pubmed/33284673
631. Yang, J., *et al.* Prospective, randomized controlled study of the preventive effect of fosfomycin tromethamine on post-transurethral resection of bladder tumor urinary tract infection. Int J Urol, 2018. 25: 894.
https://www.ncbi.nlm.nih.gov/pubmed/29999216
632. Sanaee, M.S., *et al.* Urinary tract infection prevention after midurethral slings in pelvic floor reconstructive surgery: A systematic review and meta-analysis. Acta Obstet Gynecol Scand, 2019. 98: 1514.
https://www.ncbi.nlm.nih.gov/pubmed/31112286

633. Crawford, D., *et al.* Infectious Outcomes from Renal Tumor Ablation: Prophylactic Antibiotics or Not? Cardiovasc Intervent Radiol, 2018. 41: 1573.
https://www.ncbi.nlm.nih.gov/pubmed/30062444
634. Ploussard, G., *et al.* Transperineal Versus Transrectal Magnetic Resonance Imaging-targeted Biopsies for Prostate Cancer Diagnosis: Final Results of the Randomized PERFECT trial (CCAFU-PR1). European Urology Oncology, 2024. 7: 1080.
https://www.sciencedirect.com/science/article/pii/S258893112400049X
635. Mian, B.M., *et al.* Complications Following Transrectal and Transperineal Prostate Biopsy: Results of the ProBE-PC Randomized Clinical Trial. J Urol, 2024. 211: 205.
https://pubmed.ncbi.nlm.nih.gov/37976319
636. Hu, J.C., *et al.* Transperineal Versus Transrectal Magnetic Resonance Imaging-targeted and Systematic Prostate Biopsy to Prevent Infectious Complications: The PREVENT Randomized Trial. Eur Urol, 2024. 86: 61.
https://www.ncbi.nlm.nih.gov/pubmed/38212178
637. Hu, J.C., *et al.* Transperineal vs Transrectal Prostate Biopsy—The PREVENT Randomized Clinical Trial. JAMA Oncology, 2024. 10: 1590.
https://pubmed.ncbi.nlm.nih.gov/39298143/
638. Bryant, R.J., *et al.* Local anaesthetic transperineal biopsy versus transrectal prostate biopsy in prostate cancer detection (TRANSLATE): a multicentre, randomised, controlled trial. The lancet. Oncology, 2025. 26: 583.
https://pubmed.ncbi.nlm.nih.gov/40139210
639. Tricard, T., *et al.* Transperineal MRI-guided Prostate Biopsy: a Prospective Randomized Controlled Study on Safety and Efficacy. Journal of vascular and interventional radiology: JVIR, 2025.
https://pubmed.ncbi.nlm.nih.gov/40389061/
640. Pradere, B., *et al.* Nonantibiotic Strategies for the Prevention of Infectious Complications following Prostate Biopsy: A Systematic Review and Meta-Analysis. J Urol, 2021. 205: 653.
https://www.ncbi.nlm.nih.gov/pubmed/33026903
641. Lam, W., *et al.* Abstracts of the Hong Kong Urological Association 26th Annual Scientific Meeting, Hong Kong, 17 October 2021. BJU Int, 2022. 129 Suppl 1: 4.
https://www.ncbi.nlm.nih.gov/pubmed/35202507
642. Stangl, F.P., *et al.* Infectious Complications After Transrectal Versus Transperineal Prostate Biopsy: A Systematic Review and Meta-analysis. Eur Urol Focus, 2025.
https://www.ncbi.nlm.nih.gov/pubmed/40774844
643. Bennett, H.Y., *et al.* The global burden of major infectious complications following prostate biopsy. Epidemiol Infect, 2016. 144: 1784.
https://www.ncbi.nlm.nih.gov/pubmed/26645476
644. Berry, B., *et al.* Comparison of complications after transrectal and transperineal prostate biopsy: a national population-based study. BJU Int, 2020. 126: 97.
https://www.ncbi.nlm.nih.gov/pubmed/32124525
645. Mian, B.M., *et al.* Reply: complications Following Transrectal and Transperineal Prostate Biopsy: results of the ProBE-PC Randomized Clinical Trial. J Urol, 2024. 212: 227.
https://pubmed.ncbi.nlm.nih.gov/38728260/
646. Hu, J.C., *et al.* Transperineal vs Transrectal Prostate Biopsy-The PREVENT Randomized Clinical Trial. JAMA Oncol, 2024. 10: 1590.
https://www.ncbi.nlm.nih.gov/pubmed/39298143
647. Wolff, I., *et al.* Infectious complications following transperineal prostate biopsy with or without periprocedural antibiotic prophylaxis-a systematic review including meta-analysis of all comparative studies. Prostate Cancer and Prostatic Dis, 2025: 94.
https://pubmed.ncbi.nlm.nih.gov/39741175
648. Basourakos, S.P., *et al.* Role of Prophylactic Antibiotics in Transperineal Prostate Biopsy: A Systematic Review and Meta-analysis. Eur Urol Open Sci, 2022. 37: 53.
https://www.ncbi.nlm.nih.gov/pubmed/35243391
649. Chernysheva, D.Y., *et al.* The first experience of transperineal prostate biopsy without antibiotic prophylaxis. Cancer Urology, 2021. 17: 46.
https://www.researchgate.net/publication/353446695
650. Jacewicz, M., *et al.* Antibiotic prophylaxis versus no antibiotic prophylaxis in transperineal prostate biopsies (NORAPP): a randomised, open-label, non-inferiority trial. Lancet Infect Dis, 2022. 22: 1465.
https://www.ncbi.nlm.nih.gov/pubmed/35839791

651. Shaker, H.S., *et al.* Does The Use Of Povidone Iodine Suppository Decrease The Infective Complications Of TRUS Guided Prostate Biopsies? A Randomized Prospective Study. QJM: An International Journal of Medicine, 2020. 113.
https://academic.oup.com/qjmed/article-abstract/113/Supplement_1/hcaa070.024/5829649?redirectedFrom=fulltext
652. Ergani, B., *et al.* Effect of rectal mucosa cleansing on acute prostatitis during prostate biopsy: A randomized prospective study. Turk J Urol, 2020. 46: 159.
https://www.ncbi.nlm.nih.gov/pubmed/31922485
653. Farooq, K., *et al.* Role of Povidone-Iodine-Soaked Gauze in Preventing Infectious Complications Following Trans Rectal Digital Guided Prostate Biopsy. Journal of Postgraduate Medical Institute, 2021. 35: 225.
https://jpmi.org.pk/index.php/jpmi/article/view/2849
654. Cetin, T., *et al.* Saline cleansing can prevent infective complications after transrectal prostate biopsy: A randomized prospective study. Urologia Journal, 2024. 91: 768
https://pubmed.ncbi.nlm.nih.gov/39212152/
655. Taher, Y., *et al.* (2014) Prospective randomized controlled study to assess the effect of perineal region cleansing with povidone iodine before transrectal needle biopsy of the prostate on infectious complications. Urology 84, S306.
https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01023606/full
656. Yu, L., *et al.* [Impact of insertion timing of iodophor cotton ball on the control of infection complications after transrectal ultrasound guided prostate biopsy]. Zhonghua Yi Xue Za Zhi, 2014. 94: 609.
https://www.ncbi.nlm.nih.gov/pubmed/24762693
657. Ezenwa, E.V., *et al.* Apical peri-prostatic nerve block versus intra-rectal xylocaine gel for trans- rectal ultrasound guided prostate biopsy among Nigerian patients: A prospective randomized study. Niger J Clin Pract, 2020. 23: 1183.
https://www.ncbi.nlm.nih.gov/pubmed/32913154
658. Jang, H., *et al.* Comparison of intrarectal heated lidocaine gel and periprostatic nerve block for pain control in transrectal ultrasound-guided prostate biopsy: A randomized controlled non-inferiority trial. Prostate Int, 2023. 11: 8.
https://www.ncbi.nlm.nih.gov/pubmed/36910899
659. Russo, F., *et al.* MR-tergeted vs. TRUS-guided prostate biopsy in patients with high PSA values: A randomizied controlled trial. Anticancer Research, 2016. 36: 2556.
https://ar.iiarjournals.org/content/anticanres/36/5/2535.full.pdf
660. Pilatz, A., *et al.* Antibiotic Prophylaxis for the Prevention of Infectious Complications following Prostate Biopsy: A Systematic Review and Meta-Analysis. J Urol, 2020. 204: 224.
https://www.ncbi.nlm.nih.gov/pubmed/32105195
661. Bouzouita, A., *et al.* Antimicrobial prophylaxis protocol based on rectal swab culture before prostate biopsy to prevent infectious complications: a prospective randomized comparative study. Int Urol Nephrol, 2024. 56: 2495.
https://www.ncbi.nlm.nih.gov/pubmed/38448785
662. Sadahira, T., *et al.* Significance of Targeted Antimicrobial Prophylaxis Using Rectal-culture Selective Screening Media Prior to Transrectal Prostate Biopsy: A Multicenter, Randomized Controlled Trial. Urology, 2025. 196: 32.
https://pubmed.ncbi.nlm.nih.gov/39694101
663. Supreeth, N., *et al.* Prospective randomized controlled study of comparing efficacy of prophylactic intraprostatic antibiotic injection with oral antibiotic verses standard oral prophylaxis in patients undergoing transrectal ultrasonography guided prostate biopsy. Indian Journal of Urology, 2023. 39: S3.
664. Andreasson, A., *et al.* Fosfomycin versus Ciprofloxacin as transrectal prostatebiopsy antibiotic prophylaxis - an open randomized controlled multicenter drug trial. Eur Urol, 2023. 83: S180.
https://www.sciencedirect.com/science/article/abs/pii/S0302283823001835
665. Feher, A.M., *et al.* Single-dose vs prolonged antibiotic prophylaxis of fosfomycin for transrectal prostate biopsy: a single-center prospective, randomized, controlled trial. Prostate International, 2025. 13: 28
https://pubmed.ncbi.nlm.nih.gov/40213351/
666. Carignan, A., *et al.* Effectiveness of fosfomycin tromethamine prophylaxis in preventing infection following transrectal ultrasound-guided prostate needle biopsy: Results from a large Canadian cohort. J Glob Antimicrob Resist, 2019. 17: 112.
https://www.ncbi.nlm.nih.gov/pubmed/30553114
667. Pilatz, A., *et al.* European Association of Urology Position Paper on the Prevention of Infectious Complications Following Prostate Biopsy. Eur Urol, 2021. 79: 11.
https://www.ncbi.nlm.nih.gov/pubmed/33172721

5. CONFLICT OF INTEREST

All members of the EAU Urological Infections Guidelines Panel have provided disclosure statements on all relationships that they have that might be perceived to be a potential source of a conflict of interest. This information in provided below and is also publicly accessible through the EAU website: https://uroweb.org/guidelines/urological-infections. These Guidelines were developed with the financial support of the EAU. No external sources of funding and support have been involved. The EAU is a non-profit organisation, and funding is limited to administrative assistance, travel and meeting expenses. No honoraria or other reimbursements have been provided.

Disclosures: The EAU Guidelines Office certifies that all conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject matter or materials discussed in the manuscript (e.g. employment/ affiliation, grants or funding, consultancies, honoraria, stock ownership or options, expert testimony, royalties, or patents filed, received, or pending), are the following:

G. Bonkat reported receiving company honoraria from Bionorica SE, IBSA, OM Pharma SA, Sun Pharmaceutical Industries (Europe) B.V., Zambon SpA and Hoechst Marion Roussel; fellowship and travel grants from Bionorica SE, OM Pharma SA, Sun Pharmaceutical Industries (Europe) B.V. and IBSA; and being a company consultant for IBSA, OM Pharma SA, Zambon SpA, Sun Pharma and Janssen-Cilag AG. S.E. Geerlings reported being a company consultant for Immontek.

J. Kranz reported receiving company honoraria from Apogepha, Bionorica SE, GSK, Johnson & Johnson, medac GmbH, MSD, OM-Pharma, Repha GmbH and Sysmex; being a company consultant for Bionorica SE, Eumedica, GSK, Johnson & Johnson, medac GmbH, OM-Pharma, Repha GmbH, Shionogi and Sysmex; and receiving research funding from the German Research Foundation (DFG) and LEO Pharma.

J. Medina-Palo reported receiving company speaker honorarium from Boston Scientific SA, GSK, Astellas and Q-Pharma.

L. Schneidewind reported receiving fellowship and travel grants from Apogepha Arzneimittel GmbH and Debiopharma; receiving company speaker honorarium from Bionorica SE; being a company consultant Bristol Myers Squibb, GSK, and MSD Pharma; being the receipt of grants/research supports from DFG, Monika-Kutzner Foundation and DFIT e. V.; and being a member of the German AWMF S3 Guidelines.

S. Schubert reported being the receipt of honoraria or consultation fees from OM Pharma; and being a company consultant for Janssen.

M. Vallée reported participation in a company sponsored speaker's bureau of IBSA Pharma SAS, Eumedica, GSK and OM Pharma.

F.M.E. Wagenlehner reported being a company consultant for Achaogen, Bionorica, GSK, Janssen, Klosterfrau, Pfizer, MIP Pharma, Shionogi, Spero, VenatorRX and OM-Pharma; receiving company speaker honorarium from Astellas, AstraZeneca, Bionorica, GSK, Janssen, Klosterfrau, MSD, Pfizer, MIP Pharma and OM-Pharma; trial participation for GSK, Klosterfrau, Select Immune, Janssen and VenatoRx; and receipt of grants/research supports from DFG and DZIF.

K. Bausch reported receiving company honoraria from IBSA.

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T, Cai, B. Köves, G. Mantica, A. Pilatz, R. Veeratterapillay, M. Lambregts, W. Devlies and L. Leitner have nothing to declare.

6. CITATION INFORMATION

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