

EAU Guidelines on Urological Infections

G. Bonkat (Chair), R. Bartoletti, F. Bruyère, T. Cai,
S.E. Geerlings, B. Köves, J. Kranz, S. Schubert,
A. Pilatz, R. Veeratterapillay, F. Wagenlehner
Guidelines Associates: K. Bausch, W. Devlies,
J. Horváth, L. Leitner, G. Mantica, T. Mezei
Guidelines Office: E.J. Smith, H. Ali

TABLE OF CONTENTS

PAGE

1.	INTRODUCTION	7
1.1	Aim and objectives	7
1.2	Panel composition	7
1.3	Available publications	7
1.4	Publication history	7
2.	METHODS	7
2.1	Introduction	7
2.2	Review	8
3.	THE GUIDELINE	8
3.1	Classification	8
3.2	Antimicrobial Stewardship	9
3.3	Asymptomatic bacteriuria in adults	10
3.3.1	Background	10
3.3.2	Epidemiology, aetiology and pathophysiology	10
3.3.3	Diagnostic evaluation	10
3.3.4	Evidence summary	10
3.3.5	Disease management	11
3.3.5.1	Patients without identified risk factors	11
3.3.5.2	Patients with ABU and recurrent UTI, otherwise healthy	11
3.3.5.3	Pregnant women	11
3.3.5.3.1	Is treatment of ABU beneficial in pregnant women?	11
3.3.5.3.2	Which treatment duration should be applied to treat ABU in pregnancy?	11
3.3.5.3.2.1	Single dose vs. short course treatment	12
3.3.5.4	Patients with identified risk-factors	12
3.3.5.4.1	Diabetes mellitus	12
3.3.5.4.2	ABU in post-menopausal women	12
3.3.5.4.3	Elderly institutionalised patients	12
3.3.5.4.4	Patients with renal transplants	12
3.3.5.4.5	Patients with dysfunctional and/or reconstructed lower urinary tracts	13
3.3.5.4.6	Patients with catheters in the urinary tract	13
3.3.5.4.7	Patients with ABU subjected to catheter placements/exchanges	13
3.3.5.4.8	Immuno-compromised and severely diseased patients, patients with candiduria	13
3.3.5.5	Prior to urological surgery	13
3.3.5.6	Prior to orthopaedic surgery	14
3.3.5.7	Prior to cardiovascular surgery	14
3.3.5.8	Pharmacological management	14
3.3.6	Follow-up	14
3.3.7	Summary of evidence and recommendations for the management of ABU	14
3.4	Uncomplicated cystitis	15
3.4.1	Introduction	15
3.4.2	Epidemiology, aetiology and pathophysiology	15
3.4.3	Diagnostic evaluation	15
3.4.3.1	Clinical diagnosis	15
3.4.3.2	Differential diagnosis	15
3.4.3.3	Laboratory diagnosis	15
3.4.3.4	Summary of evidence and recommendations for the diagnostic evaluation of uncomplicated cystitis	15

3.4.4	Disease management	16
3.4.4.1	Cystitis in pregnancy	16
3.4.4.2	Cystitis in men	16
3.4.4.3	Renal insufficiency	17
3.4.4.4	Summary of evidence and recommendations for antimicrobial therapy for uncomplicated cystitis	17
3.4.5	Follow-up	18
3.5	Recurrent UTIs	18
3.5.1	Introduction	18
3.5.2	Diagnostic evaluation	18
3.5.3	Disease management and follow-up	18
3.5.3.1	Evidence Summary	18
3.5.3.2	Behavioural modifications	18
3.5.3.3	Non-antimicrobial prophylaxis	19
3.5.3.3.1	Hormonal replacement	19
3.5.3.3.2	Immunoactive prophylaxis	19
3.5.3.3.3	Prophylaxis with probiotics (<i>Lactobacillus</i> spp.)	19
3.5.3.3.4	Prophylaxis with cranberry	19
3.5.3.3.5	Prophylaxis with D-mannose	20
3.5.3.3.6	Endovesical instillation	20
3.5.3.3.7	Methenamine hippurate	20
3.5.3.4	Antimicrobials for preventing rUTI	20
3.5.3.4.1	Continuous low-dose antimicrobial prophylaxis and post-coital prophylaxis	20
3.5.3.4.2	Self-diagnosis and self-treatment	21
3.5.4	Summary of evidence and recommendations for the diagnostic evaluation and treatment of rUTIs	21
3.6	Uncomplicated pyelonephritis	22
3.6.1	Diagnostic evaluation	22
3.6.1.1	Clinical diagnosis	22
3.6.1.2	Differential diagnosis	22
3.6.1.3	Laboratory diagnosis	22
3.6.1.4	Imaging diagnosis	22
3.6.2	Summary of evidence and recommendations for the diagnostic evaluation of uncomplicated pyelonephritis	22
3.6.3	Disease management	23
3.6.3.1	Outpatient treatment	23
3.6.3.2	Inpatient treatment	23
3.6.3.2.1	Summary of evidence and recommendations for the treatment of uncomplicated pyelonephritis	23
3.6.4	Follow-up	24
3.7	Complicated UTIs	25
3.7.1	Introduction	25
3.7.2	Diagnostic evaluation	25
3.7.2.1	Clinical presentation	25
3.7.2.2	Urine culture	25
3.7.3	Microbiology (spectrum and antimicrobial resistance)	25
3.7.4	General principles of cUTI treatment	25
3.7.4.1	Choice of antimicrobials	25
3.7.4.2	Duration of antimicrobial therapy	26
3.7.5	Summary of evidence and recommendations for the treatment of complicated UTIs	26
3.8	Catheter-associated UTIs	27
3.8.1	Introduction	27
3.8.2	Epidemiology, aetiology and pathophysiology	27

3.8.3	Diagnostic evaluation	27
3.8.3.1	Clinical diagnosis	27
3.8.3.2	Laboratory diagnosis	27
3.8.3.3	Summary of evidence table and recommendations for diagnostic evaluation of CA-UTI	28
3.8.4	Disease management	28
3.8.4.1	Limiting catheterisation and appropriate catheter discontinuation	28
3.8.4.2	Urethral cleaning and chlorhexidine bathing	28
3.8.4.3	Alternatives to indwelling urethral catheterisation	28
3.8.4.4	Impregnated or coated catheters	29
3.8.4.5	Antibiotic prophylaxis for catheter removal or insertion	29
3.8.4.6	Antibiotic prophylaxis for intermittent self-catheterisation (ISC)	29
3.8.4.7	Antimicrobial treatment for suspected CA-UTI	29
3.8.4.8	Recommendations for disease management and prevention of CA-UTI	30
3.9	Urosepsis	30
3.9.1	Introduction	30
3.9.2	Epidemiology, aetiology and pathophysiology	31
3.9.3	Diagnostic evaluation	31
3.9.4	Physiology and biochemical markers	32
3.9.4.1	Cytokines as markers of the septic response	32
3.9.4.2	Biochemical markers	32
3.9.5	Disease management	32
3.9.5.1	Prevention	32
3.9.5.1.1	Preventive measures of proven or probable efficacy	32
3.9.5.1.2	Appropriate peri-operative antimicrobial prophylaxis	32
3.9.5.2	Treatment	33
3.9.5.2.1	Antimicrobial therapy	33
3.9.5.2.2	Source control	33
3.9.5.2.3	Adjunctive measures	33
3.9.5.3	Summary of evidence and recommendations for the diagnosis and treatment of urosepsis	33
3.10	Urethritis	34
3.10.1	Introduction	34
3.10.2	Epidemiology, aetiology and pathogenesis	34
3.10.3	Evidence Summary	34
3.10.4	Diagnostic evaluation	35
3.10.5	Disease management	35
3.10.5.1	Gonococcal urethritis	35
3.10.5.2	Non-gonococcal urethritis	36
3.10.6	Follow-up	36
3.10.7	Summary of evidence and recommendations for the diagnostic evaluation and antimicrobial treatment of urethritis	36
3.11	Bacterial Prostatitis	38
3.11.1	Introduction	38
3.11.2	Evidence Summary	38
3.11.3	Epidemiology, aetiology and pathogenesis	39
3.11.4	Diagnostic evaluation	39
3.11.4.1	History and symptoms	39
3.11.4.2	Symptom questionnaires	39
3.11.4.3	Clinical findings	39
3.11.4.4	Urine cultures and expressed prostatic secretion	39
3.11.4.5	Prostate biopsy	39
3.11.4.6	Other tests	39

3.11.4.7	Additional investigations	40
3.11.4.7.1	Ejaculate analysis	40
3.11.4.7.2	First-void urine sample	40
3.11.4.7.3	Prostate specific antigen (PSA)	40
3.11.4.8	Summary of evidence and recommendations for the diagnosis of bacterial prostatitis	40
3.11.5	Disease management	40
3.11.5.1	Antimicrobials	40
3.11.5.2	Intraprostatic injection of antimicrobials	41
3.11.5.3	Combined treatments	41
3.11.5.4	Drainage and surgery	41
3.11.5.5	Summary of evidence and recommendations for the disease management of bacterial prostatitis	41
3.11.6	Follow-up	42
3.12	Acute Infective Epididymitis	42
3.12.1	Epidemiology, Aetiology and Pathophysiology	42
3.12.2	Diagnostic Evaluation	42
3.12.3	Disease Management	43
3.12.4	Evidence Summary	43
3.12.5	Screening	43
3.12.6	Summary of evidence and recommendations for the diagnosis and treatment of acute infective epididymitis	44
3.13	Fournier's Gangrene (Necrotising fasciitis of the perineum and external genitalia)	46
3.13.1	Epidemiology, Aetiology and Pathophysiology	46
3.13.2	Diagnostic Evaluation	46
3.13.3	Disease Management	46
3.13.4	Evidence Summary	46
3.13.5	Summary of evidence and recommendations for the disease management of Fournier's Gangrene	47
3.14	Management of Human papillomavirus in men	47
3.14.1	Epidemiology	47
3.14.2	Risk factors	48
3.14.3	Transmission	48
3.14.4	Clearance	48
3.14.5	Diagnosis	48
3.14.6	Treatment of HPV related diseases	48
3.14.6.1	Treatments suitable for self-application	48
3.14.6.2	Physician-administered treatment	49
3.14.6.3	Summary of evidence and recommendations for the treatment of anogenital warts	49
3.14.7	Circumcision for reduction of HPV prevalence	49
3.14.8	Therapeutic vaccination	50
3.14.9	Prophylactic vaccination	50
3.15	Genitourinary Tuberculosis	52
3.15.1	Epidemiology, Aetiology and Pathophysiology	52
3.15.2	Diagnosis	52
3.15.2.1	Smear Microscopy	52
3.15.2.2	Culture	52
3.15.2.3	Nucleic Acid Amplification Tests	52
3.15.2.4	Imaging	52
3.15.3	Medical Treatment	53
3.15.4	Surgical treatment	53
3.15.5	Summary of evidence and recommendations for the diagnosis and treatment of GUTB	54

3.16	Peri-Procedural Antibiotic Prophylaxis	55
3.16.1	General Principles	55
3.16.1.1	Definition of infectious complications	55
3.16.1.2	Non-antibiotic measures for asepsis	55
3.16.1.3	Detection of bacteriuria prior to urological procedures	55
3.16.1.4	Choice of agent	55
3.16.2	Specific procedures and evidence question	56
3.16.2.1	Urodynamics	56
3.16.2.2	Cystoscopy	56
3.16.2.3	Interventions for urinary stone treatment	56
3.16.2.3.1	Extracorporeal shockwave lithotripsy	56
3.16.2.3.2	Ureteroscopy	57
3.16.2.3.3	Percutaneous nephrolithotomy (PNL)	57
3.16.2.4	Transurethral resection of the prostate	57
3.16.2.5	Transurethral resection of the bladder	58
3.16.2.6	Midurethral slings	58
3.16.2.7	Renal tumour ablation	58
3.16.2.8	Prostate biopsy	58
3.16.2.8.1	Transperineal prostate biopsy	58
3.16.2.8.2	Transrectal prostate biopsy	58
3.16.3	Summary of evidence and recommendations for peri-procedural antibiotic prophylaxis	59
4.	REFERENCES	63
5.	CONFLICT OF INTEREST	92
6.	CITATION INFORMATION	92

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 on 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, 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 Uroweb: <http://uroweb.org/guideline/urological-infections/>.

1.3 Available publications

A quick reference document, the Pocket Guidelines, is available in print. This is an abridged version, which may require consultation together with the full text version. All documents are accessible through the EAU website Uroweb: <http://uroweb.org/guideline/urological-infections/>.

1.4 Publication history

The Urological Infections Guidelines were first published in 2001. This 2024 document presents a limited update of the 2023 publication.

1.4.1 Summary of changes

Key changes in the 2024 guideline:-

- Section 3.3 - Asymptomatic Bacteriuria in Adults – This section has been extensively updated resulting in a new recommendation and a revised recommendation.

Recommendations	Strength rating
Do not screen or treat asymptomatic bacteriuria in patients prior to cardiovascular surgeries.	Weak
Screen for and treat asymptomatic bacteriuria in pregnant women with standard short course treatment or single dose fosfomycin trometamol.	Weak

- Section 3.16.2.8 – Peri-Procedural Antibiotic Prophylaxis - Prostate Biopsy – The text of this section has been updated, following assessment of the literature.

2. METHODS

2.1 Introduction

For the 2024 Urological Infections Guidelines, new and relevant evidence was identified, collated and appraised through a structured assessment of the literature for sections 3.3 Asymptomatic Bacteriuria in Adults and 3.16.2.8 Peri-Procedural Antibiotic Prophylaxis - Prostate Biopsy. Broad and comprehensive literature searches, covering these sections were performed. 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
3.3 Asymptomatic Bacteriuria in Adults	1,503	Dec 1st 2016 - June 1st 2023
3.16.2.8 Peri-Procedural Antibiotic Prophylaxis - Prostate Biopsy	179	June 1st 2022 - June 1st 2023

Detailed search strategies are available online: <https://uroweb.org/guidelines/urological-infections/publications-appendices>. In addition, the current evidence base of section 3.5 Recurrent UTI was re-assessed and the recommendations reviewed.

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 a number of key elements:

1. the overall quality of the evidence which 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;
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

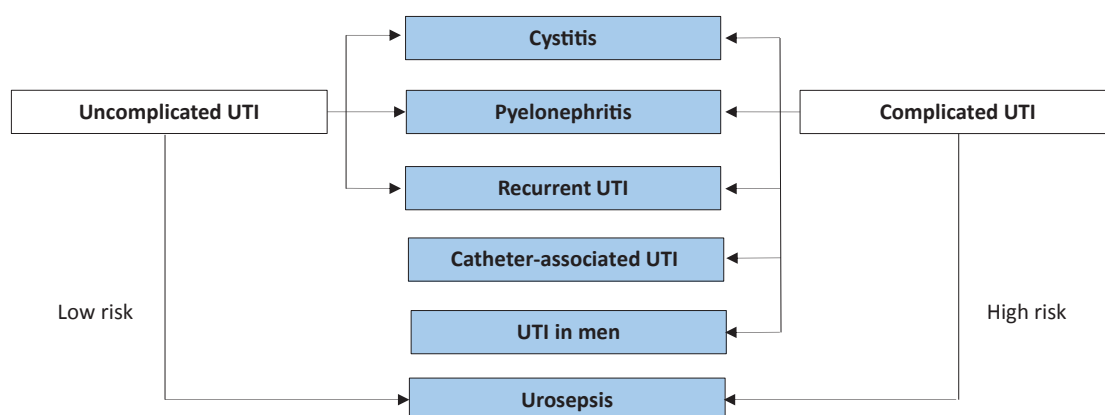
This document was subject to independent peer review prior to publication in 2019.

3. THE GUIDELINE

3.1 Classification

Different classification systems of UTI exist. Most widely used are those developed by the Centres for Disease Control and Prevention (CDC) [5], Infectious Diseases Society of America (IDSA) [6], European Society of Clinical Microbiology and Infectious Diseases (ESCMID) [7] as well as the U.S. Food and Drug Administration (FDA) [8, 9]. Current UTI guidelines frequently use the concept of uncomplicated and complicated UTI with a number of modifications (Figure 1). In 2011 the EAU Section of Infections in Urology proposed the ORENUC classification system based on the clinical presentation of the UTI, the anatomical level of the UTI, the grade of severity of the infection, the categorisation of risk factors and availability of appropriate antimicrobial therapy [10].

Figure 1: Concept of uncomplicated and complicated UTI



The following classification of UTIs is adopted in the EAU Urological Infections Guidelines:

Classification of UTI	
Uncomplicated UTIs	Acute, sporadic or recurrent lower (uncomplicated cystitis) and/or upper (uncomplicated pyelonephritis) UTI, limited to non-pregnant women with no known relevant anatomical and functional abnormalities within the urinary tract or comorbidities.
Complicated UTIs	All UTIs which are not defined as uncomplicated. Meaning in a narrower sense UTIs in a patient with an increased chance of a complicated course: i.e. all men, pregnant women, patients with relevant anatomical or functional abnormalities of the urinary tract, indwelling urinary catheters, renal diseases, and/or with other concomitant immunocompromising diseases for example, diabetes.
Recurrent UTIs	Recurrences of uncomplicated and/or complicated UTIs, with a frequency of at least three UTIs/year or two UTIs in the last six months.
Catheter-associated UTIs	Catheter-associated urinary tract infection (CA-UTI) refers to UTIs occurring in a person whose urinary tract is currently catheterised or has had a catheter in place within the past 48 hours.
Urosepsis	Urosepsis is defined as life threatening organ dysfunction caused by a dysregulated host response to infection originating from the urinary tract and/or male genital organs [11].

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 [12, 13]. In acute care hospitals, 20-50% of prescribed antibiotics are either unnecessary or inappropriate [14]. In response, a worldwide initiative seeks to incorporate Antimicrobial Stewardship programs in healthcare [15]. Antimicrobial Stewardship aims to 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 [16].

Stewardship programs have two main sets of actions. The first set mandates 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 [17].

The important components of antimicrobial stewardship programs are [18]:

- 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;
- 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 more narrow spectrum agent), showed a RRR of 56% (95% CI 34 – 70%) for mortality [19].

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 [20]. Its use in the Netherlands appeared to result in shortened hospital stay [21]. A literature search of Pubmed from April 2014 [19], 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 [22]. Clinical studies have shown that ABU may protect against superinfecting UTI, thus treatment of ABU should be performed only in cases of proven benefit for the patient to avoid the risk of selecting antimicrobial resistance and eradicating a potentially protective ABU strain [23, 24]. 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 pre-menopausal females. Increasing to 4-19% in otherwise healthy elderly females and men, 0.7-27% in patients with diabetes, 2-10% in pregnant women, 15-50% in institutionalised elderly populations, and in 23-89% in patients with spinal cord injuries [25]. 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 uncomplicated or complicated UTIs, depending on the presence of risk factors (see sections 3.4 and 3.7).

3.3.3 Diagnostic evaluation

Asymptomatic bacteriuria is defined by a mid-stream sample of urine showing bacterial growth $\geq 10^5$ cfu/mL in two consecutive samples in women [26] and in one single sample in men [27] 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, i.e. *Proteus mirabilis* is detected, stone formation in the urinary tract must be excluded [28, 29, 235]. In men, a digital rectal examination (DRE) has to 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 [30]. For the subgroups of pregnancy, prior to urologic surgeries, post-menopausal women and institutionalised elderly patients only data from RCTs were included, on which a meta-analysis was performed [30]. For the other subgroups non-RCTs were also included in the narrative analysis [30]. An update systematic literature search from 1st December 2016 to 1st 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: immuno-compromised 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**

3.3.5.1 *Patients without identified risk factors*

Asymptomatic bacteriuria does not cause renal disease or damage [31]. Only one prospective, non-randomised study investigated the effect of treatment of ABU in adult, non-diabetic, non-pregnant women [32], and found no difference in the rate of symptomatic UTIs. Furthermore, 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.

3.3.5.2 *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 [24] and demonstrated that treatment of ABU increases the risk for a subsequent symptomatic UTI episode, compared to non-treated patients (RR 0.28, 95% CI 0.21 to 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.

3.3.5.3 *Pregnant women*

3.3.5.3.1 *Is treatment of ABU beneficial in pregnant women?*

Twelve RCTs comparing antibiotic treatments of ABU with placebo controls or no treatment [33-44], with different 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 [33, 35-43, 45]. Antibiotic treatment significantly reduced the number of symptomatic UTIs compared to placebo or no treatment (average RR 0.22, 95% CI 0.12 to 0.40).

Six RCTs reported on the resolution of bacteriuria [33-35, 37, 40, 42]. Antibiotic treatment was effective in the resolution of bacteriuria compared to placebo (average RR 2.99, 95% CI 1.65 to 5.39; n=716). Eight RCTs reported on the rate of low birthweights [33, 35-38, 41, 44, 45]. Antibiotic treatment was associated with lower rates of low birthweight compared to placebo or no treatment (average RR 0.58, 95% CI 0.36 to 0.94; n=1689). Four RCTs reported on the rate of preterm deliveries [41, 42, 44, 45]. Antibiotic treatment was associated with lower rates of preterm delivery compared to placebo or no treatment (average RR 0.34, 95% CI 0.18 to 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 [46-48]. 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 60s to 80s. 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 [45]. Therefore, it is advisable to consult national recommendations for pregnant women.

3.3.5.3.2 *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 [49-64]. There was significant heterogeneity 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 by Widmer *et al.* was adopted with some modifications [65]. 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 [50, 54, 55, 59-64], one study compared single dose to long course treatment [58] and one study compared long course to continuous treatment [51]. 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.

3.3.5.3.2.1 Single dose vs. short course treatment

Three RCTs reported on the rate of symptomatic UTIs [54, 63, 64], with no significant difference between the two durations (average RR 1.07, 95% CI 0.47 to 2.47; n=891). Nine RCTs reported on the rate of ABU resolution [50, 54, 55, 59-64], with no significant difference between the two durations (average RR 0.97, 95% CI 0.89 to 1.07; n=1,268). Six RCTs reported on the rate of side effects [50, 54, 59, 60, 62, 63]. Single dose treatment was associated with significantly less side effects compared to short course treatment (average RR 0.40, 95% CI 0.22 to 0.72; n=458). Three RCTs reported on the rate of preterm deliveries [54, 56, 64], with no significant difference between the two durations (average RR 1.16, 95% CI 0.75 to 1.78; n=814). One RCT reported on the rate of low birthweights [64]. 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 to 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 lower uncomplicated UTIs or ABU reported on a subgroup analysis of pregnant women with ABU [66]. 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.

3.3.5.4 Patients with identified risk-factors

3.3.5.4.1 Diabetes mellitus

Diabetes mellitus, even when well regulated, is reported to correlate to a higher frequency of ABU [67]. 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. Furthermore, untreated ABU did not correlate to diabetic nephropathy [68]. 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.

3.3.5.4.2 ABU in post-menopausal women

Elderly women have an increased incidence of ABU [69]. Four RCTs compared antibiotic treatment of ABU with placebo controls or no treatment, in a post-menopausal female population, with different antibiotic doses and regimens [70-73]. 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 to 1.05; 208 women) and the resolution of bacteriuria (average RR 1.28, 95% CI 0.50 to 3.24; 203 women) [54, 63, 64], with no significant benefit of antibiotic treatment. Therefore, ABU in post-menopausal women does not require treatment, and should be managed as for pre-menopausal women.

3.3.5.4.3 Elderly institutionalised patients

The rate of ABU is 15-50% in elderly institutionalised patients [74]. 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 [75, 76]. Seven RCTs compared antibiotic treatment of ABU with placebo controls or no treatment in elderly patients, with different antibiotic doses and regimens [70-73, 77-79].

Three RCTs reported on the rate of symptomatic UTIs [70, 72, 77]. 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 to 1.00; n=210). Six RCTs reported on the resolution of bacteriuria [70, 72, 73, 77-79]. There was no benefit of antibiotic treatment compared to placebo in the resolution of ABU (average RR 1.33, 95% CI 0.63 to 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 [80]. 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 [81]. Therefore, screening and treatment of ABU is not recommended in this patient group.

3.3.5.4.4 Patients with renal transplants

Two RCTs and two retrospective studies compared the effect of antibiotic treatment to no treatment in renal transplant patients [82-85]. 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 to 1.45; n=200). The two retrospective studies reached the same conclusion. Furthermore, there were no significant differences in the rate of ABU clearance, graft loss or change in renal function during long-term follow-up to 24 months [82-85].

A further two RCTs [86, 87], one observational study [88] and two systematic reviews and meta-analyses [89, 90] were identified. The first RCT reported that during the first 2 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 vs. no treatment [86]. 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 [87]. The first of the two additional meta-analyses reported the same results as the original study [89]. 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 [90]. 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]) [90].

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

3.3.5.4.5 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 [91, 92]. A systematic review reported ABU prevalence rates ranging from 25-86% for intestinal conduits in 4 studies and 9.1-85% for orthotopic neobladders in 9 studies [93]. Studies have shown no long-term benefit in ABU treatment in these patient groups [84, 85, 93].

Furthermore, 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 [94, 95]. 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.

3.3.5.4.6 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 [96]. This is also applicable for patients with ABU and indwelling ureteral stents [97]. Routine treatment of catheter-associated bacteriuria is not recommended. For detailed recommendations see section 3.8.

3.3.5.4.7 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 [98]. In patients subjected to placement/exchanges of nephrostomy tubes and indwelling ureteral stents, ABU is considered a risk factor for infectious complications [99].

3.3.5.4.8 Immuno-compromised and severely diseased patients, patients with candiduria

These patient groups have to be considered individually and the benefit of screening and treatment of ABU should be reviewed in each case. Patients with asymptomatic candiduria may, although not necessarily, have an underlying disorder or defect. Treatment of asymptomatic candiduria is not recommended [100].

3.3.5.5 Prior to urological surgery

In diagnostic and therapeutic procedures not entering the urinary tract, ABU is generally not considered as 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 endoscopic urological surgery, bacteriuria is a definite risk factor.

Two RCTs [101, 102] and two prospective non-randomised studies [103, 104] 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 to 0.86; $n=167$). The rates of post-operative 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 post-operative UTIs between single-dose or 3-5 days short term pre-operative antibiotic treatment of ABU [105].

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

3.3.5.6 *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 [106, 107]. 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 post-operative symptomatic UTI (0.65% vs. 2.7%) [107]. One further RCT investigated the efficacy of pre-operative 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) [108]. Furthermore, four additional meta-analyses did not find a benefit for pre-operative screening or treatment of ABU prior to orthopaedic surgery [109-112]. Therefore, treatment of bacteriuria is not recommended prior to arthroplasty surgery.

3.3.5.7 *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 [113]. The procedures performed were non-valvular coronary artery bypass grafting (42%), valvular replacements (51%) and thoracic aortic surgeries (7%). Pre-operative 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 pre-operative 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 limited conclusions can be drawn from this. Further studies with appropriate design and sample size are needed to confirm these findings.

3.3.5.8 *Pharmacological management*

If the decision is taken to eradicate ABU, the same choice of antibiotics and treatment duration as in symptomatic uncomplicated (section 3.4.4.4) or complicated (section 3.7.5) UTI can be given, depending on gender, medical background and presence of complicating factors. 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
• post-menopausal 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 recent study reported lower rates of pyelonephritis in low-risk women.	1a

Recommendations	Strength rating
Do not screen or treat asymptomatic bacteriuria in the following conditions: <ul style="list-style-type: none"> • 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

3.4 Uncomplicated cystitis

3.4.1 Introduction

Uncomplicated cystitis is defined as acute, sporadic or recurrent cystitis limited to non-pregnant women with no known relevant anatomical and functional abnormalities within the urinary tract or comorbidities.

3.4.2 Epidemiology, aetiology and pathophysiology

Almost 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 years [114]. Risk factors include sexual intercourse, use of spermicides, a new sexual partner, a mother with a history of UTI and a history of UTI during childhood. The majority of cases of uncomplicated cystitis are caused by *E. coli*.

3.4.3 Diagnostic evaluation

3.4.3.1 Clinical diagnosis

The diagnosis of uncomplicated 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 [115, 116]. In elderly women genitourinary symptoms are not necessarily related to cystitis [117, 118].

3.4.3.2 Differential diagnosis

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

3.4.3.3 Laboratory diagnosis

In patients presenting with typical symptoms of an uncomplicated cystitis urine analysis (i.e. urine culture, dip stick testing, etc.) leads only to a minimal increase in diagnostic accuracy [119]. However, if the diagnosis is unclear dipstick analysis can increase the likelihood of an uncomplicated cystitis diagnosis [120, 121]. Taking a urine culture is recommended in patients with atypical symptoms, as well as those who fail to respond to appropriate antimicrobial therapy [122, 123].

3.4.3.4 Summary of evidence and recommendations for the diagnostic evaluation of uncomplicated cystitis

Summary of evidence	LE
An accurate diagnosis of uncomplicated cystitis 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 uncomplicated cystitis in women who have no other risk factors for complicated urinary tract infections based on: <ul style="list-style-type: none"> • 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 uncomplicated cystitis.	Weak
Urine cultures should be done in the following situations: <ul style="list-style-type: none"> • suspected acute pyelonephritis; • symptoms that do not resolve or recur within four weeks after completion of treatment; • women who present with atypical symptoms; • pregnant women. 	Strong

3.4.4 Disease management

Antimicrobial therapy is recommended because clinical success is significantly more likely in women treated with antimicrobials compared with placebo [124]. In female patients with mild to moderate symptoms, symptomatic therapy (e.g. Ibuprofen, phytotherapy), as an alternative to antimicrobial treatment, may be considered in consultation with individual patients [125-129]. The choice of antimicrobial therapy should be guided by [115]:

- 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 3 g single dose, pivmecillinam 400 mg three times a day for three to five days, and nitrofurantoin (e.g. nitrofurantoin monohydrate/macrocrystals 100 mg twice daily for five days), should be considered for first-line treatment, when available [130-133].

Alternative antimicrobials include trimethoprim alone or combined with a sulphonamide. Co-trimoxazole (160/800 mg twice daily for three days) or trimethoprim (200 mg 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% [134, 135].

Aminopenicillins are no longer suitable for empirical therapy because of 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 [136, 137].

Important note:

On 11th March 2019, the European Commission implemented stringent regulatory conditions regarding the use of fluoroquinolones due to their disabling and potentially long-lasting side effects [138]. 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 uncomplicated 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 [138].

3.4.4.1 Cystitis in pregnancy

Short courses of antimicrobial therapy can also be considered for treatment of cystitis in pregnancy [139], 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.

3.4.4.2 Cystitis in men

Cystitis in men without involvement of the prostate is uncommon and should be classed as a complicated infection. Therefore, treatment with antimicrobials penetrating into the prostate tissue is needed in males with symptoms of UTI. A treatment duration of at least seven days is recommended, preferably with trimethoprim-sulphamethoxazole or a fluoroquinolone if in accordance with susceptibility testing (see section 3.4.4.4) [140].

3.4.4.3 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 glomerular filtration rate (GFR) is < 20 mL/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 glomerular filtration rate (eGFR) of less than 30 ml/min/1.73m² as accumulation of the drug leads to increased side effects as well as reduced urinary tract recovery, with the risk of treatment failure [141].

3.4.4.4 Summary of evidence and recommendations for antimicrobial therapy for uncomplicated cystitis

Summary of evidence	LE
Clinical success for the treatment of uncomplicated cystitis is significantly more likely in women treated with antimicrobials than placebo.	1b
Aminopenicillins are no longer suitable for antimicrobial therapy in uncomplicated cystitis because of negative ecological effects, high resistance rates and their increased selection for extended spectrum beta-lactamase (ESBL)-producing bacteria.	3

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

Table 1: Suggested regimens for antimicrobial therapy in uncomplicated cystitis

Antimicrobial	Daily dose	Duration of therapy	Comments
First-line women			
Fosfomycin trometamol	3 g SD	1 day	Recommended only in women with uncomplicated cystitis.
Nitrofurantoin macrocrystal	50-100 mg four times a day	5 days	
Nitrofurantoin monohydrate/ macrocrystals	100 mg b.i.d	5 days	
Nitrofurantoin macrocrystal prolonged release	100 mg b.i.d	5 days	
Pivmecillinam	400 mg t.i.d	3-5 days	
Alternatives			
Cephalosporins (e.g. cefadroxil)	500 mg b.i.d	3 days	Or comparable
If the local resistance pattern for E. coli is < 20%			
Trimethoprim	200 mg b.i.d	5 days	Not in the first trimester of pregnancy
Trimethoprim-sulfamethoxazole	160/800 mg b.i.d	3 days	Not in the last trimester of pregnancy
Treatment in men			
Trimethoprim-sulfamethoxazole	160/800 mg b.i.d	7 days	Restricted to men, fluoroquinolones can also be prescribed in accordance with local susceptibility testing.

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

3.4.5 **Follow-up**

Routine post-treatment urinalysis or urine cultures in asymptomatic patients are not indicated [25]. 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 [142]. 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 [142].

3.5 **Recurrent UTIs**

3.5.1 **Introduction**

Recurrent UTIs (rUTIs) are recurrences of uncomplicated and/or complicated UTIs, with a frequency of at least three UTIs/year or two UTIs in the last six months. Although rUTIs include both lower tract infection (cystitis) and upper tract infection (pyelonephritis), repeated pyelonephritis should prompt consideration of a complicated aetiology. Recurrent UTIs negatively impact patient quality of life leading to a reduction in the quality of social and sexual relationships, self-esteem and capacity for work [143].

3.5.2 **Diagnostic evaluation**

Recurrent UTIs are common. Risk factors are outlined in Table 2. Initial diagnosis of rUTI should be confirmed by urine culture. An extensive routine workup including cystoscopy, imaging, etc. is not routinely recommended as the diagnostic yield is low [144]. However, it should be performed without delay in atypical cases, for example, if renal calculi, outflow obstruction, interstitial cystitis or urothelial cancer is suspected.

Table 2: Age-related associations of rUTI in women [74, 117, 145]

Young and pre-menopausal women	Post-menopausal and elderly women
Sexual intercourse	History of UTI before menopause
Use of spermicide	Urinary incontinence
A new sexual partner	Atrophic vaginitis due to oestrogen deficiency
A mother with a history of UTI	Cystocele
History of UTI during childhood	Increased post-void urine volume
Blood group antigen secretory status	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 rUTIs includes counselling regarding avoidance of risk factors, non-antimicrobial measures and antimicrobial prophylaxis [142, 146]. 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.

3.5.3.1 **Evidence Summary**

A broad literature with cut-off of 31st May 2021 identified 3,604 abstracts of which 361 were selected for full text review. In total 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 cut-off date of 1st 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?

3.5.3.2 **Behavioural modifications**

Women with rUTI should be counselled on avoidance of risks (e.g., insufficient drinking, habitual and post-coital delayed urination, wiping from front to back after defecation, douching and wearing occlusive underwear) before initiation of long-term prophylactic drug treatment, although there is limited evidence available regarding these approaches [147, 148]. An open-label RCT found that additional fluid intake of 1.5 L a day in premenopausal women with rUTI who were low-volume drinkers (< 1.5 L a day) reduced the number of cystitis episodes and antibiotic usage over a 12-month period [149]

3.5.3.3 Non-antimicrobial prophylaxis

3.5.3.3.1 Hormonal replacement

Based on the results of four meta-analyses topical oestrogen therapy (either as a creme or a pessary) shows a trend towards rUTI prevention [150-153]. 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 rUTI prophylaxis compared to placebo, furthermore it was associated with an unfavourable systematic side effect profile. A single prospective, non-comparative study of 30 pre-menopausal women with rUTI on oral contraceptives reported a beneficial effect for additional topical oestrogen therapy [154].

3.5.3.3.2 Immunoactive prophylaxis

Several meta-analyses and systematic reviews based on nine RCTs showed that oral immunotherapy with OM-89 is an effective and safe method for the prevention of rUTIs compared to placebo at short-term follow up (< 6 months) [151, 155, 156].

A vaginal suppository containing ten strains of heat-killed uropathogenic bacteria significantly reduced the risk of rUTI compared to placebo in a meta-analysis of three small RCTs [155-157]. The preventive effect was more pronounced with booster treatment.

A systematic review of two retrospective and three prospective cohort studies concluded that MV140 may decrease the number of rUTI episodes and/or increase the probability of patients being UTI free [158]. A placebo controlled RCT of MV140 reported a significant decrease in rUTI episodes in both MV140 groups vs. placebo [159]. At 12 months follow-up 25% of women treated with placebo (95% CI, 15% to 35%) were UTI free compared with 56% (95% CI, 44% to 67%) and 58% (95% CI, 44% to 67%) of women who received three and six months of MV140 treatment, respectively. The median number of UTI episodes per patient was 3.0 (0.5 to 6.0) for the placebo group compared with 0.0 (0.0 to 1.0) in both groups receiving MV140 [159].

A comparative single-centre study of 124 women vaccinated with StroVac compared to 49 women receiving antibiotic prophylaxis with 24-month follow-up concluded that StroVac is an effective non-antibiotic prophylaxis for rUTI [160]. However, this study was not randomised or blinded resulting in a high risk of bias (selection and imprecision).

3.5.3.3.3 Prophylaxis with probiotics (*Lactobacillus* spp.)

Five meta-analyses with differing results and eleven relevant systematic reviews were identified [151, 161-174]. Two meta-analyses reported significant positive effects for rUTI prevention with effective probiotics compared to placebo [165, 167]. The contradictory results of the four meta-analyses are a result of the analysis of different *Lactobacillus* strains and different administration regimes, treatment durations, and patient populations. Most studies concluded that not all *Lactobacillus* strains are effective for vaginal flora restoration and rUTI 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 [151, 163, 165, 167]. Although meta-analyses including all known *Lactobacilli* strains did not show a significant treatment benefit [151, 163, 165, 167], sensitivity analysis excluding studies using ineffective strains resulted in a positive treatment effect [165].

Of the eleven systematic reviews, seven concluded that prophylaxis with vaginal probiotics has a beneficial clinical impact for the prevention of rUTI [152, 153, 161, 164, 166, 168-171, 173]. The available data is too minimal or of low quality to allow the panel to make recommendations on the route of admission, optimal dosage, and treatment duration for probiotic prophylaxis.

3.5.3.3.4 Prophylaxis with cranberry

Seven meta-analyses and several systematic reviews were identified [151, 175-180]. A Cochrane systematic review and meta-analysis found that when compared with placebo, water or not treatment, cranberry products did not significantly reduce the occurrence of symptomatic UTI overall or in women with recurrent UTIs [175]. However, six subsequent meta-analyses concluded that consumption of cranberry-containing products may protect against UTIs in certain patient populations [151, 176-180]. The differing outcomes across the meta-analyses can be contributed to the clinical and methodological heterogeneity of the included studies [181]. A RCT of 145 women randomised to high-dose vs. low-dose cranberry proanthocyanidin extract reported no significant reduction in the number of symptomatic UTI episodes between the groups [182]. Although the efficacy of cranberry products remains unclear, the panel consensus is that clinicians may recommend them for rUTI 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.

3.5.3.3.5 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 rUTI prevention compared to placebo with comparable efficacy to antibiotic prophylaxis [183]. Another systematic review, concluded that D-mannose had a significant effect on UTI, but that further studies were needed to confirm these findings [161]. A further systematic review including 695 patients reported that D-Mannose improved quality of life and significantly reduced rUTIs in both catheter and non-catheter users and was effective in reducing the incidence of rUTIs and prolonging UTI-free periods [184]. However, a Cochrane systematic review including 719 patients was unable to determine if D-mannose when compared to no treatment, other supplements or antibiotics significantly reduced the number of rUTI episodes [185]. The overall quality of the evidence was low.

3.5.3.3.6 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 rUTI [186]. A meta-analysis (n=143) based on two RCTs and two non-RCTs found significantly decreased UTI rates per patient/year and significantly longer mean UTI recurrence times for HA and HA-CS therapy compared to control treatment [187]. In addition, subgroup analysis of the two RCTs using HA-CS reported a significantly decreased UTI rate per patient-year, significantly longer mean UTI recurrence time and a significantly better pelvic pain and urgency/frequency (PUF) total score. However, 24-h urinary frequency measured as number of voids in 3 days were not significantly improved after therapy [187].

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 UTI rate per patient-year and a significantly longer time to UTI recurrence [188]. Furthermore, HA-CS therapy was associated with significantly greater mean reductions in PUF total and symptom scores and the percentage of patients with UTI recurrence during follow-up was also lower [188].

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

3.5.3.3.7 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 UTI in patients without renal tract abnormalities, particularly when used for short-term prophylaxis [189]. 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 rUTIs there was no statistically significant difference between the efficacy of methenamine hippurate and any comparators [190]. 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 UTIs decreased to 1.38 episodes per person per year for the methenamine hippurate group vs. 0.89 episodes per person per year for the antibiotic group. The absolute difference was 0.49 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 [191, 192].

3.5.3.4 *Antimicrobials for preventing rUTI*

3.5.3.4.1 Continuous low-dose antimicrobial prophylaxis and post-coital prophylaxis

Four meta-analyses and numerous systematic reviews and guidelines were identified [153, 193-203]. All available meta-analyses conclude that antibiotic prophylaxis is the most effective approach against UTI recurrences compared with placebo or no treatment [193-195]. Antimicrobials may be given as continuous low-dose prophylaxis for longer periods, or as post-coital prophylaxis. There is no significant difference in the efficacy of the two approaches. There is no consensus about the optimal duration of continuous antimicrobial prophylaxis, with studies reporting treatment duration of three to twelve months. After discontinuation of the drug, UTIs tend to re-occur, especially among those, who have had three or more infections annually. It is mandatory to offer both continuous low-dose antimicrobial and post-coital prophylaxis after counselling, and when behavioural modifications as well as non-antimicrobial measures have been unsuccessful.

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 50 mg or 100 mg once daily, fosfomycin trometamol 3 g every ten days, trimethoprim 100 mg once daily and during pregnancy cephalixin 125 mg or 250 mg or cefaclor 250 mg once daily [142, 204]. Post-coital prophylaxis should be considered in pregnant women with a history of frequent UTIs before onset of pregnancy, to reduce their risk of UTI [205].

3.5.3.4.2 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 [206]. The choice of antimicrobials is the same as for sporadic acute uncomplicated UTI (section 3.4.4.4).

3.5.4 Summary of evidence and recommendations for the diagnostic evaluation and treatment of rUTIs

Summary of evidence	LE
Extensive routine workup including cystoscopy, imaging, etc. has a low diagnostic yield for the diagnosis of rUTI.	3
Increased water intake is an effective antimicrobial-sparing strategy to prevent rUTI in premenopausal women at high risk for recurrence who drink low volumes (< 1.5 L) of fluid daily.	3
Vaginal oestrogen replacement has shown a trend towards preventing rUTI in post-menopausal women.	1b
Immunoactive prophylaxis has been shown to be more effective than placebo for in female patients with rUTIs in several randomised trials with a good safety profile.	1a
Probiotics containing <i>L. rhamnosus</i> GR-1, <i>L. reuteri</i> B-54 and RC-14, <i>L. casei</i> shirota, or <i>L. crispatus</i> CTV-05 are effective for vaginal flora restoration and have shown a trend towards prevention of rUTIs.	1b
Current scientific evidence regarding the efficacy of cranberry products in the prevention of UTIs is inconclusive.	1a
There is contradictory evidence on the efficacy of D-mannose to reduce the number of UTI episodes.	2
Based on limited evidence intravesical GAG therapy can reduce the number of UTIs per patient per year, and prolong the time interval between rUTI episodes.	2
A RCT demonstrated the non-inferiority of twice-daily methenamine hippurate to daily antibiotic prophylaxis.	1b
Both continuous low-dose antimicrobial prophylaxis and post-coital antimicrobial prophylaxis, have been shown to reduce the rate of rUTI.	1b
A prospective cohort study showed that intermittent self-start therapy is effective, safe and economical in women with rUTIs.	2b

Recommendations	Strength rating
Diagnose recurrent UTI 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 UTI and no risk factors.	Weak
Advise pre-menopausal women regarding increased fluid intake as it might reduce the risk of recurrent UTI.	Weak
Use vaginal oestrogen replacement in post-menopausal women to prevent recurrent UTI.	Strong
Use immunoactive prophylaxis to reduce recurrent UTI in all age groups.	Strong
Advise patients on the use of local or oral probiotic containing strains of proven efficacy for vaginal flora regeneration to prevent UTIs.	Weak
Advise patients on the use of cranberry products to reduce recurrent UTI episodes; however, patients should be informed that the quality of evidence underpinning this is low with contradictory findings.	Weak
Use D-mannose to reduce recurrent UTI episodes, but patients should be informed of the overall weak and contradictory evidence of its effectiveness.	Weak
Use methenamine hippurate to reduce recurrent UTI 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 UTIs in patients where 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 post-coital antimicrobial prophylaxis to prevent recurrent UTI when non-antimicrobial interventions have failed. Counsel patients regarding possible side effects.	Strong
For patients with good compliance self-administered short-term antimicrobial therapy should be considered.	Strong

3.6 Uncomplicated pyelonephritis

Uncomplicated pyelonephritis is defined as pyelonephritis limited to non-pregnant, pre-menopausal women with no known relevant urological abnormalities or comorbidities.

3.6.1 Diagnostic evaluation

3.6.1.1 Clinical diagnosis

Pyelonephritis is suggested by fever (> 38°C), chills, flank pain, nausea, vomiting, or costovertebral angle tenderness, with or without the typical symptoms of cystitis [207]. Pregnant women with acute pyelonephritis need special attention, as this kind 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 pre-term labour and birth [208].

3.6.1.2 Differential diagnosis

It is vital to differentiate as soon as possible between uncomplicated and complicated mostly obstructive pyelonephritis, as the latter can rapidly lead to urosepsis. This differential diagnosis should be made by the appropriate imaging technique (see section 3.6.1.4).

3.6.1.3 Laboratory diagnosis

Urinalysis including the assessment of white and red blood cells and nitrite, is recommended for routine diagnosis [209]. In addition, urine culture and antimicrobial susceptibility testing should be performed in all cases of pyelonephritis.

3.6.1.4 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 [210]. 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 [210]. 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 [210].

3.6.2 Summary of evidence and recommendations for the diagnostic evaluation of uncomplicated 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 selectively be applied in adults with febrile 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 done if the patient remains febrile after 72 hours of treatment or in patients with suspected complications e.g. 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

3.6.3.1 Outpatient treatment

Fluoroquinolones and cephalosporines are the only antimicrobial agents that can be recommended for oral empirical treatment of uncomplicated pyelonephritis [211]. 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 [212]. In the setting of fluoroquinolone hypersensitivity or known resistance, other acceptable choices include trimethoprim-sulfamethoxazole (160/800 mg) 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. A short outpatient antibiotic course of treatment, for acute pyelonephritis, 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 [213].

3.6.3.2 Inpatient treatment

Patients with uncomplicated 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 [214]. Ceftolozane/tazobactam achieved a clinical response rate of over 90% in patients with uncomplicated pyelonephritis [215, 216]. It also demonstrated significantly higher composite cure rates than levofloxacin among levofloxacin-resistant pathogens [217]. Ceftazidime-avibactam combination has been shown to be effective for treating ceftazidime-resistant *Enterobacterales* and *Pseudomonas aeruginosa* UTIs [218].

Novel antimicrobial agents include imipenem/cilastatin, cefiderocol, meropenem-vaborbactam and plazomicin. Imipenem/cilastatin has been investigated in a phase 2 randomised trial and showed good clinical response rates [219]. Cefatazidime-avibactam and doripenem showed similar efficacy against ceftazidime non-susceptible pathogens and may offer an alternative to carbapenems in this setting [220]. Meropenem-vaborbactam has been shown to be non-inferior to piperacillin-tazobactam in a phase 3 RCT [221]. It was also effective for treating carbapenem-resistant *Enterobacterales* with cure rates of 65% compared to best available treatment [222]. Once daily plazomicin was non-inferior to meropenem for the treatment of cUTIs and acute pyelonephritis caused by *Enterobacterales*, including multidrug-resistant strains [223]. Cefiderocol was non-inferior to imipenem/cilastatin for the treatment of complicated UTI in people with multidrug-resistant Gram-negative infections in a phase 2 RCT [224].

Carbapenems and novel broad spectrum antimicrobial agents should only be considered in patients with early culture results indicating the presence of multi-drug 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 [225]. Patients initially treated with parenteral therapy who improve clinically and can tolerate oral fluids may transition to oral antimicrobial therapy [226].

3.6.3.2.1 Summary of evidence and recommendations for the treatment of uncomplicated pyelonephritis

Summary of evidence	LE
Fluoroquinolones and cephalosporines are the only microbial agents that can be recommended for oral empirical treatment of uncomplicated pyelonephritis.	1b
Intravenous antimicrobial regimens for uncomplicated 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 multi-drug 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 uncomplicated pyelonephritis not requiring hospitalisation with short course fluoroquinolones as first-line treatment.	Strong
Treat patients with uncomplicated 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 uncomplicated pyelonephritis.	Strong

Table 3: Suggested regimens for empirical oral antimicrobial therapy in uncomplicated pyelonephritis

Antimicrobial	Daily dose	Duration of therapy	Comments
Ciprofloxacin	500-750 mg b.i.d	7 days	Fluoroquinolone resistance should be less than 10%.
Levofloxacin	750 mg q.d	5 days	
Trimethoprim sulfamethoxazol	160/800 mg 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	200 mg b.i.d	10 days	
Ceftibuten	400 mg q.d	10 days	

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

Table 4: Suggested regimens for empirical parenteral antimicrobial therapy in uncomplicated pyelonephritis

Antimicrobials	Daily dose	Comments
First-line treatment		
Ciprofloxacin	400 mg b.i.d	
Levofloxacin	750 mg q.d	
Cefotaxime	2 g t.i.d	Not studied as monotherapy in acute uncomplicated pyelonephritis.
Ceftriaxone	1-2 g q.d	Lower dose studied, but higher dose recommended.
Second-line treatment		
Cefepime	1-2 g b.i.d	Lower dose studied, but higher dose recommended.
Piperacillin/tazobactam	2.5-4.5 g t.i.d	
Gentamicin	5 mg/kg q.d	Not studied as monotherapy in acute uncomplicated pyelonephritis.
Amikacin	15 mg/kg q.d	
Last-line alternatives		
Imipenem/cilastatin	0.5 g t.i.d	Consider only in patients with early culture results indicating the presence of multi-drug resistant organisms.
Meropenem	1 g t.i.d	
Ceftolozane/tazobactam	1.5 g t.i.d	
Ceftazidime/avibactam	2.5 g t.i.d	
Cefiderocol	2g t.i.d	
Meropenem-vaborbactam	2g t.i.d	
Plazomicin	15mg/kg o.d	

b.i.d = twice daily; t.i.d = three times daily; q.d = every day; 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 [227, 228]. 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 [229].

3.6.4 Follow-up

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

3.7 Complicated UTIs

3.7.1 Introduction

Complicated UTI (cUTI) occurs in an individual in whom factors related to the host (e.g. underlying diabetes or immunosuppression) or specific anatomical or functional abnormalities related to the urinary tract (e.g. obstruction, incomplete voiding due to detrusor muscle dysfunction) are believed to result in an infection that will be more difficult to eradicate than an uncomplicated infection [230-232]. New insights into the management of cUTIs also suggest to consider infections caused by multi-drug resistant uropathogens [233]. The underlying factors that are generally accepted to result in a cUTI are outlined in Table 5. The designation of cUTI encompasses a wide variety of underlying conditions that result in a remarkably heterogeneous patient population. Therefore, it is readily apparent that a universal approach to the evaluation and treatment of cUTIs is not sufficient, although there are general principles of management that can be applied to the majority of patients with cUTIs. The following recommendations are based on the Stichting Werkgroep Antibioticabeleid (SWAB) Guidelines from the Dutch Working Party on Antibiotic Policy [234].

Table 5: Common factors associated with complicated UTIs [233-236]

Obstruction at any site in the urinary tract	UTI in males
Foreign body	Pregnancy
Incomplete voiding	Diabetes mellitus
Vesicoureteral reflux	Immunosuppression
Recent history of instrumentation	Healthcare-associated infections
Isolated ESBL-producing organisms	Isolated multi-drug resistant organisms

3.7.2 Diagnostic evaluation

3.7.2.1 Clinical presentation

A cUTI is associated with clinical symptoms (e.g. dysuria, urgency, frequency, flank pain, costovertebral angle tenderness, suprapubic pain and fever), although in some clinical situations the symptoms may be atypical for example, in NLUTD, CA-UTI or patients who have undergone radical cystectomy with urinary diversion. In addition, all patients with nephrostomy may have an atypical clinical presentation. Clinical presentation can vary from severe obstructive acute pyelonephritis with imminent urosepsis to a post-operative CA-UTI, which might disappear spontaneously as soon as the catheter is removed. Clinicians must also recognise that symptoms, especially lower urinary tract symptoms (LUTS), are not only caused by UTIs but also by other urological disorders, such as, for example, bladder outlet obstruction and autonomic dysfunction in patients with spinal lesions and NLUTD. Concomitant medical conditions, such as diabetes mellitus and renal failure, which can be related to urological abnormalities, are often also present in a cUTI.

3.7.2.2 Urine culture

Laboratory urine culture is the recommended method to determine the presence or absence of clinically significant bacteriuria in patients suspected of having a cUTI.

3.7.3 Microbiology (spectrum and antimicrobial resistance)

A broad range of micro-organisms cause cUTIs. The spectrum is much larger than in uncomplicated UTIs and the bacteria are more likely to be resistant (especially in treatment-related cUTI) than those isolated in uncomplicated UTIs [235, 236]. *E. coli*, *Proteus spp.*, *Klebsiella spp.*, *Pseudomonas spp.*, *Serratia spp.* and *Enterococcus spp.* are the most common species found in cultures. *Enterobacterales* predominate (60-75%), with *E. coli* as the most common pathogen; particularly if the UTI is a first infection. Otherwise, the bacterial spectrum may vary over time and from one hospital to another [237].

3.7.4 General principles of cUTI treatment

Appropriate management of the urological abnormality or the underlying complicating factor is mandatory. Optimal antimicrobial therapy for cUTI depends on the severity of illness at presentation, as well as local resistance patterns and specific host factors (such as allergies). In addition, urine culture and susceptibility testing should be performed, and initial empirical therapy should be tailored and followed by (oral) administration of an appropriate antimicrobial agent on the basis of the isolated uropathogen.

3.7.4.1 Choice of antimicrobials

Considering the current resistance percentages of amoxicillin, co-amoxiclav, trimethoprim and trimethoprim-sulphamethoxazole, it can be concluded that these agents are not suitable for the empirical treatment of

pyelonephritis in a normal host and, therefore, also not for treatment of all cUTIs [238]. The same applies to ciprofloxacin and other fluoroquinolones in urological patients [238].

Patients with a UTI with systemic symptoms requiring hospitalisation should be initially treated with an intravenous antimicrobial regimen, such as an aminoglycoside with or without amoxicillin, or a second or third generation cephalosporin, or an extended-spectrum penicillin with or without an aminoglycoside [234]. The choice between these agents should be based on local resistance data, and the regimen should be tailored on the basis of susceptibility results [212]. These recommendations are not only suitable for pyelonephritis, but for all other cUTIs.

Alternative regimens for the treatment of cUTIs, particularly those caused by multidrug-resistant pathogens have been studied. Ceftolozane/tazobactam 1.5 g every eight hours demonstrated high clinical cure rates for cUTIs caused by ESBL-producing *Enterobacterales* in a pooled analysis of phase 3 clinical trials [239]. Cefiderocol (2 g) three times daily was non-inferior to imipenem-cilastatin (1 g) three times daily for the treatment of cUTI in patients with multidrug-resistant Gram-negative infections [224]. Imipenem/cilastatin plus relebactam (250 or 125 mg) was as effective as imipenem/cilastatin alone for treatment of cUTI in a phase 2 RCT [219]. Ceftazidime/avibactam has been shown to be as effective as carbapenems for the treatment of cUTI in a systematic review reporting a baseline of 25% for ESBL-producing *Enterobacterales*, but more severe adverse events were reported in the ceftazidime/avibactam group [240]. Once-daily plazomicin was shown to be non-inferior to meropenem for the treatment of cUTIs caused by *Enterobacterales*, including multidrug-resistant strains [223].

In view of the high degree of resistance, particularly among patients admitted to the department of urology, fluoroquinolones are not automatically suitable as empirical antimicrobial therapy, especially when the patient has used ciprofloxacin in the last six months [241]. Fluoroquinolones can only be recommended as empirical treatment when the patient is not seriously ill and it is considered safe to start initial oral treatment or if the patient has had an anaphylactic reaction to beta-lactam antimicrobials. Intravenous levofloxacin 750 mg once daily for five days has been shown to be non-inferior to a seven to fourteen days regimen of levofloxacin 500 mg once daily starting intravenously and switched to an oral regimen (based on mitigation of clinical symptoms) [242].

3.7.4.2 Duration of antimicrobial therapy

Treatment for seven [243] to fourteen days (for men fourteen days when prostatitis cannot be excluded) [244], is generally recommended, but the duration should be closely related to the treatment of the underlying abnormality. When the patient is hemodynamically stable and afebrile for at least 48 hours, a shorter treatment duration (e.g. seven days) may be considered in patients where a short-course treatment is desired due to relative-contraindications to the administered antibiotic [242].

3.7.5 Summary of evidence and recommendations for the treatment of complicated 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, if available. 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 in women with complicated pyelonephritis.	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 cUTI with systemic symptoms, empirical treatment should cover ESBL if there is an increased likelihood of ESBL infection based on prevalence in the community, earlier collected cultures and prior antimicrobial exposure of the patient.	2
Intravenous levofloxacin 750 mg once daily for five days, is non-inferior to a seven to fourteen day regimen of levofloxacin 500 mg once daily starting intravenously and switched to an oral regimen (based on mitigation of clinical symptoms).	2

Recommendations	Strength rating
Use the combination of: <ul style="list-style-type: none"> • amoxicillin plus an aminoglycoside; • a second-generation cephalosporin plus an aminoglycoside; • a third-generation cephalosporin intravenously as empirical treatment of complicated UTI with systemic symptoms. 	Strong
Only use ciprofloxacin provided that the local resistance percentages are < 10% when; <ul style="list-style-type: none"> • the entire treatment is given orally; • patients do not require hospitalisation; • patient has an anaphylaxis for beta-lactam antimicrobials. 	Strong
Do not use ciprofloxacin and other fluoroquinolones for the empirical treatment of complicated 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 [235].

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% [245]. A multistate point-prevalence survey of 11,282 patients across 183 hospitals reported that UTI accounted for 12.9% of healthcare acquired infections [246]. The incidence of bacteriuria associated with indwelling catheterisation is 3-8% per day [247-251]. The duration of catheterisation is the most important risk factor for the development of a CA-UTI [252, 253]. A systematic review and meta-analysis reported an average CA-UTI incidence of 13.79/1000 hospitalised patients with a prevalence of 9.33% [254]. 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 [254].

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 [255]. Catheter-associated UTIs are often polymicrobial and caused by multiple-drug resistant uropathogens.

3.8.3 Diagnostic evaluation

3.8.3.1 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, 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 [234]. 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 [234, 235].

3.8.3.2 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 mid-stream voided urine specimen from a patient whose urethral, suprapubic, or condom catheter has been removed within the previous 48 hours [235]. 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 [235].

3.8.3.3 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 $\geq 10^3$ 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

3.8.4.1 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 multi-modal targeted infection programs have been proven to reduce CA-UTI rates [256, 257]. 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 (including catheter discontinuation and limiting catheterisation), in nursing home patients reported successful CA-UTI reduction and reduced catheter usage [258]. 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 [259].

3.8.4.2 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 different urethral cleaning methods vs. disinfection [260]. The efficacy of chlorhexidine baths (either using 2% chlorhexidine-impregnated cloths or 4% chlorhexidine-based soap) in reducing CA-UTI is debatable. In a RCT of 10,783 ICU patients, no difference in CA-UTI rates were reported between chlorhexidine and control bathing groups [261]. 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) [262].

3.8.4.3 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 [263]. A further meta-analysis of post-partum women reported no difference in the incidence of UTI after labour between continuous catheterisation and IC [263]. 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 multi drug resistant organisms [264].

A Cochrane Review found insufficient evidence to assess the value of different policies for replacing long-term urinary catheters on patient outcomes [98]. Another Cochrane review investigating the role of urethral (indwelling or intermittent) vs. suprapubic catheterisation in the short-term found inconclusive evidence of an effect on UTI rates [265]. 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 different types of catheters could be made [266]. Therefore, based on the available literature, while there are some limited studies showing a benefit of IC or suprapubic catheterisation over urethral catheterisation for CA-UTI rates, there is insufficient evidence to recommend those approaches routinely [267].

3.8.4.4 *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 [268]. 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 [269].

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 [270]. 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 [271]. 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 [272]. However, the same study found that nitrofurazone-impregnated catheters reduce the risk of symptomatic CA-UTI; however, this was borderline significant (RR 0.84, 95% CI 0.71 to 0.99) [272]. A more recent RCT (214 patients) evaluating the use of nitrofurazone-infused catheters post-renal transplant found no benefit for their use [273]. 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 [274].

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 [267].

3.8.4.5 *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% (from 10.5% to 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 post-operatively, 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 post-operatively [275].

3.8.4.6 *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 [276]. 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 [267].

3.8.4.7 *Antimicrobial treatment for suspected CA-UTI*

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 [235]. 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; therefore, symptomatic CA-UTIs should be treated according to the recommendations for cUTI (see section 3.7.5) [277].

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 the patient remains catheterised or not [235]. 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 about 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 5-day antibiotic regimen with catheter exchange has been shown in one study to be non-inferior to a 10-day regimen with catheter retention on the basis of clinical cure [278].

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 mid-stream urine specimen should be obtained prior to the initiation of antimicrobial therapy to help guide treatment [235]. Long-term indwelling catheters should not be changed routinely. Follow appropriate practices for catheter insertion and care [279].

3.8.4.8 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 complicated UTI (see section 3.7.5).	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 CA-UTI.	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

3.9.1 Introduction

Patients with urosepsis should be diagnosed at an early stage, especially in the case of a cUTI. Systemic inflammatory response syndrome (SIRS), characterised by fever or hypothermia, leukocytosis or leukopenia, tachycardia and tachypnoea, has been recognised as a set of alerting symptoms [280, 281]; however, SIRS is no longer included in the recent terminology of sepsis (Table 6) [11]. Mortality is considerably increased the more severe the sepsis is.

The treatment of urosepsis involves adequate life-supporting care, appropriate and prompt antimicrobial therapy, adjunctive measures and the optimal management of urinary tract disorders [282]. Source control by decompression of any obstruction and drainage of larger abscesses in the urinary tract is essential [282]. Urologists are recommended to treat patients in collaboration with intensive care and infectious diseases specialists.

Urosepsis is seen in both community-acquired and healthcare associated infections. Nosocomial urosepsis may be reduced by measures used to prevent nosocomial infection, e.g. reduction of hospital stay, early removal of indwelling urinary catheters, avoidance of unnecessary urethral catheterisation, correct use of closed catheter systems, and attention to simple daily aseptic techniques to avoid cross-infection.

Sepsis is diagnosed when clinical evidence of infection is accompanied by signs of systemic inflammation, presence of symptoms of organ dysfunction and persistent hypotension associated with tissue anoxia (Table 6).

3.9.2 **Epidemiology, aetiology and pathophysiology**

Urinary tract infections can manifest from bacteriuria with limited clinical symptoms to sepsis or severe sepsis, depending on localised and potential systemic extension. It is important to note that a patient can move from an almost harmless state to severe sepsis in a very short time.

Mortality rates associated with sepsis vary depending on the organ source [283] with urinary tract sepsis generally having a lower mortality than that from other sources [284]. Sepsis is more common in men than in women [285]. In recent years, the overall incidence of sepsis arising from all sources has increased by 8.7% per year [283], but the associated mortality has decreased, which suggests improved management of patients (total in-hospital mortality rate fell from 27.8% to 17.9% from 1995 to 2000) [286]. Although the rate of sepsis due to Gram-positive and fungal organisms has increased, Gram-negative bacteria remain predominant in urosepsis [277, 287].

In urosepsis, as in other types of sepsis, the severity depends mostly upon the host response. Patients who are more likely to develop urosepsis include elderly patients, diabetics, immunosuppressed patients, such as transplant recipients and patients receiving cancer chemotherapy or corticosteroids. Urosepsis also depends on local factors, such as urinary tract calculi, obstruction at any level in the urinary tract, congenital uropathy, NLUTD, or endoscopic manoeuvres. However, all patients can be affected by bacterial species that are capable of inducing inflammation within the urinary tract.

Patients who are more likely to develop urosepsis include elderly patients, diabetics, immunosuppressed patients, such as transplant recipients and patients receiving cancer chemotherapy or corticosteroids. Urosepsis also depends on local factors, such as urinary tract calculi, obstruction at any level in the urinary tract, congenital uropathy, neurogenic bladder disorders, or endoscopic manoeuvres. However, all patients can be affected by bacterial species that are capable of inducing inflammation within the urinary tract.

3.9.3 **Diagnostic evaluation**

For diagnosis of systemic symptoms in sepsis either the full Sequential [Sepsis-related] Organ Failure Assessment (SOFA) score, or the quickSOFA score should be applied (Table 6). Microbiology sampling should be applied to urine, two sets of blood cultures [288], and if appropriate drainage fluids. Imaging investigations, such as sonography and CT-scan should be performed early [289].

Table 6: Definition and criteria of sepsis and septic shock [11, 280, 281]

Disorder	Definition
Sepsis	Life-threatening organ dysfunction caused by a dysregulated host response to infection. For clinical application, organ dysfunction can be represented by an increase in the Sequential [Sepsis-related] Organ Failure Assessment (SOFA) score of 2 points or more. For rapid identification a quickSOFA (qSOFA) score was developed: respiratory rate of 22/min or greater, altered mentation, or systolic blood pressure of 100 mmHg or less.
Septic shock	Septic shock should be defined as a subset of sepsis in which particularly profound circulatory, cellular, and metabolic abnormalities are associated with a greater risk of mortality than with sepsis alone. Patients with septic shock can be clinically identified by a vasopressor requirement to maintain a mean arterial pressure of 65 mmHg or greater and serum lactate level greater than 2 mmol/L (>18 mg/dL) in the absence of hypovolemia.

3.9.4 **Physiology and biochemical markers**

E. coli remains the most prevalent micro-organism. In several countries, bacterial strains can be resistant or multi-resistant and therefore difficult to treat [287]. Most commonly, the condition develops in compromised patients (e.g. those with diabetes or immunosuppression), with typical signs of generalised sepsis associated with local signs of infection.

3.9.4.1 *Cytokines as markers of the septic response*

Cytokines are involved in the pathogenesis of sepsis [284]. They are molecules that regulate the amplitude and duration of the host inflammatory response. They are released from various cells including monocytes, macrophages and endothelial cells, in response to various infectious stimuli. The complex balance between pro- and anti-inflammatory responses is modified in severe sepsis. An immunosuppressive phase follows the initial pro-inflammatory mechanism. Sepsis may indicate an immune system that is severely compromised and unable to eradicate pathogens or a non-regulated and excessive activation of inflammation, or both. Genetic predisposition is a probable explanation of sepsis in several patients. Mechanisms of organ failure and death in patients with sepsis remain only partially understood [284].

3.9.4.2 *Biochemical markers*

Procalcitonin is the inactive pro-peptide of calcitonin. Normally, levels are undetectable in healthy humans. During severe generalised infections (bacterial, parasitic and fungal) with systemic manifestations, procalcitonin levels rise [290]. In contrast, during severe viral infections or inflammatory reactions of non-infectious origin, procalcitonin levels show only a moderate or no increase. Mid-regional proadrenomedullin is another sepsis marker. Mid-regional proadrenomedullin has been shown to play a decisive role in the induction of hyperdynamic circulation during the early stages of sepsis and progression to septic shock [291]. Procalcitonin monitoring may be useful in patients likely to develop sepsis and to differentiate from a severe inflammatory status not due to bacterial infection [290, 292]. In addition, serum lactate is a marker of organ dysfunction and is associated with mortality in sepsis [293]. Serum lactate should therefore also be monitored in patients with severe infections.

3.9.5 **Disease management**

3.9.5.1 *Prevention*

Septic shock is the most frequent cause of death for patients hospitalised for community-acquired and nosocomial infection (20-40%). Urosepsis treatment requires a combination of treatment including source control (obstruction of the urinary tract), adequate life-support care, and appropriate antimicrobial therapy [284, 289]. In such a situation, it is recommended that urologists collaborate with intensive care and infectious disease specialists for the best management of the patient.

3.9.5.1.1 *Preventive measures of proven or probable efficacy*

The most effective methods to prevent nosocomial urosepsis are the same as those used to prevent other nosocomial infections [294, 295] they include:

- Isolation of patients with multi-resistant organisms following local and national recommendations.
- Prudent use of antimicrobial agents for prophylaxis and treatment of established infections, to avoid selection of resistant strains. Antibiotic agents should be chosen according to the predominant pathogens at a given site of infection in the hospital environment.
- Reduction in hospital stay. Long inpatient periods before surgery lead to a greater incidence of nosocomial infections.
- Early removal of indwelling urethral catheters, as soon as allowed by the patient's condition. Nosocomial UTIs are promoted by bladder catheterisation as well as by ureteral stenting [296]. Antibiotic prophylaxis does not prevent stent colonisation, which appears in 100% of patients with a permanent ureteral stent and in 70% of those temporarily stented.
- Use of closed catheter drainage and minimisation of breaks in the integrity of the system, e.g. for urine sampling or bladder wash-out.
- Use of least-invasive methods to release urinary tract obstruction until the patient is stabilised.
- Attention to simple everyday techniques to assure asepsis, including the routine use of protective disposable gloves, frequent hand disinfection, and using infectious disease control measures to prevent cross-infections.

3.9.5.1.2 *Appropriate peri-operative antimicrobial prophylaxis*

For appropriate peri-operative antimicrobial prophylaxis see section 3.15. The potential side effects of antibiotics must be considered before their administration in a prophylactic regimen.

3.9.5.2 Treatment

Early goal-directed resuscitation was initially shown to improve survival for emergency department patients presenting with septic shock in a randomised, controlled, single-centre study [297]. However, follow-up studies in an improved emergency medicine background have not achieved positive effects with this strategy [298-300]. An individual patient data meta-analysis of the later three multicentre trials concluded that early goal-directed therapy did not result in better outcomes than usual care and was associated with higher hospitalisation costs [301].

3.9.5.2.1 Antimicrobial therapy

Initial empiric antimicrobial therapy should provide broad antimicrobial coverage against all likely causative pathogens and should be adapted on the basis of culture results, once available [282, 289]. The dosage of the antimicrobial substances is of paramount importance in patients with sepsis syndrome and should generally be high, with appropriate adjustment for renal function [282]. Antimicrobials must be administered no later than one hour after clinical assumption of sepsis [282].

3.9.5.2.2 Source control

Obstruction in the urinary tract is the most frequent urological source of urosepsis. Drainage of obstruction and abscesses, and removal of foreign bodies, such as urinary catheters or stones is therefore the most important source control strategy. These are key components of the strategy. This condition is an absolute emergency.

3.9.5.2.3 Adjunctive measures

The most important adjunctive measures in the management of sepsis are the following [282, 289]:

- fluid therapy with crystalloids, or albumin, if crystalloids are not adequately increasing blood pressure: passive leg raising-induced changes in cardiac output and in arterial pulse pressure are predictors of fluid responsiveness in adults [302];
- as vasopressors norepinephrine should be used primarily, dobutamine in myocardial dysfunction;
- hydrocortisone should be given only if fluid and vasopressors do not achieve a mean arterial pressure of ≥ 65 mmHg;
- blood products should be given to target a haemoglobin level of 7-9 g/dL;
- mechanical ventilation should be applied with a tidal volume 6 mL/kg and plateau pressure ≤ 30 cm H₂O and a high positive end-expiratory pressure;
- sedation should be given minimally, neuromuscular blocking agents should be avoided;
- glucose levels should be target at ≤ 180 mg/dL;
- deep vein thrombosis prevention should be given with low-molecular weight heparin subcutaneously;
- stress ulcer prophylaxis should be applied in patients at risk, using proton pump inhibitors;
- enteral nutrition should be started early (< 48 hours).

In conclusion, sepsis in urology remains a severe situation with a considerable mortality rate. A recent campaign, 'Surviving Sepsis Guidelines', aims to reduce mortality by 25% in the next years [282, 289, 303]. Early recognition of the symptoms may decrease the mortality by timely treatment of urinary tract disorders, e.g. obstruction, or urolithiasis. Adequate life-support measures and appropriate antimicrobial treatment provide the best conditions for improving patient survival. The prevention of sepsis is dependent on good practice to avoid nosocomial infections and using antimicrobial prophylaxis and therapy in a prudent and well-accepted manner.

3.9.5.3 Summary of evidence and recommendations for the diagnosis and treatment of urosepsis

Summary of evidence	LE
Initial high dose empiric antimicrobial therapy, administered within the first hour, should provide broad antimicrobial coverage against all likely causative pathogens and should be adapted on the basis of culture results, once available.	2b
Source control interventions should be implemented as soon as possible to control or eliminate diagnosed and/or suspected infectious foci.	3

Recommendations	Strength rating
Perform the quickSOFA score to identify patients with potential sepsis.	Strong
Take a urine culture and two sets of blood cultures before starting antimicrobial treatment.	Strong
Administer parenteral high dose broad spectrum antimicrobials within the first hour after clinical assumption of sepsis.	Strong

Adapt initial empiric antimicrobial therapy on the basis of culture results.	Strong
Initiate source control including removal of foreign bodies, decompression of obstruction and drainage of abscesses in the urinary tract.	Strong
Provide immediate adequate life-support measures.	Strong

Table 7: Suggested regimens for antimicrobial therapy for urosepsis.

Antimicrobials	Daily dose	Duration of therapy
Cefotaxime	2 g t.i.d	7-10 days Longer courses are appropriate in patients who have a slow clinical response
Ceftazidime	1-2 g t.i.d	
Ceftriaxone	1-2 g q.d	
Cefepime	2 g b.i.d	
Piperacillin/tazobactam	4.5 g t.i.d	
Ceftolozane/tazobactam	1.5 g t.i.d	
Ceftazidime/avibactam	2.5 g t.i.d	
Gentamicin*	5 mg/kg q.d	
Amikacin*	15 mg/kg q.d	
Ertapenem	1 g q.d	
Imipenem/cilastatin	0.5 g t.i.d	
Meropenem	1 g t.i.d	

* Not studied as monotherapy in urosepsis

b.i.d = twice daily; t.i.d = three times daily; q.d = every day.

3.10 Urethritis

3.10.1 Introduction

Urethritis can be of either infectious or non-infectious origin. Inflammation of the urethra presents usually with LUTS and must be distinguished from other infections of the lower urinary tract. Urethral infection is typically spread by sexual contact.

3.10.2 Epidemiology, aetiology and pathogenesis

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 *Chlamydia trachomatis*, *Mycoplasma genitalium*, *Ureaplasma 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].

Causative agents 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 men or cervicitis, endometritis and salpingitis in women [306].

Mucopurulent or purulent discharge, dysuria and urethral pruritus are symptoms of urethritis. However, many infections of the urethra are asymptomatic.

3.10.3 Evidence Summary

A systematic search of the literature from January 2014 until February 2019 identified 488 titles of which 71 were selected for full text review. Thirteen systematic reviews or guidelines based on systematic literature searches [304-316], and seventeen original publications [317-333] were selected for further analysis. In addition, a further eleven relevant publications were identified from the references of the reviewed literature [334-344]. The evidence questions addressed were:

1. In patients with urethritis what is the best method of detecting the causative pathogen?
2. In patients with urethritis what are the best treatment strategies for clinical or microbiological cure?

3.10.4 Diagnostic evaluation

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

- Mucoid, mucopurulent, or purulent urethral discharge.
- Gram or methylene-blue stain of urethral secretions demonstrating inflammation. Five or more polymorphonuclear leucocytes (PMNL) per high power field (HPF) is the historical cut-off for the diagnosis of urethritis. A threshold of ≥ 2 PMNL/HPF was proposed recently based on better diagnostic accuracy [321, 334-336], but this was not supported by other studies [320]. Therefore, in line with the 2016 European Guideline on the management of NGU [305] the use of ≥ 5 PMNL/HPF cut-off level 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 in the Gram stain of urethral secretions with gonococci located intracellularly 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 testing) if available to obtain objective evidence of urethral inflammation and to guide treatment [305, 306, 319]. Recent studies showed that processing time of point-of-care diagnostics is highly relevant in terms of patient compliance and real-life applicability [317, 318].

Men who meet the criteria for urethritis should be tested for *C. trachomatis*, *M. genitalium* and *N. gonorrhoea* with nucleic acid amplification tests (NAAT), even if point-of-care tests are negative for gonorrhoeae [305, 308]. The sensitivity and specificity of NAATs is better than that of any of the other tests available for the diagnosis of chlamydial and gonococcal infections [309, 337]. The performance of first-catch urine is non-inferior to urethral swabs [337]. In case of delayed treatment, if a NAAT is positive for gonorrhoea, a culture using urethral swabs should be performed before treatment to assess the antimicrobial resistance profile of the infective strain [306]. *N. gonorrhoeae* and *C. trachomatis* cultures are mainly used to evaluate treatment failures and monitor developing resistance to current treatment. *Trichomonas* spp. can usually be identified microscopically [306] or by NAATs [311].

Non-gonococcal urethritis is classified as persistent when symptoms do not resolve within three to four weeks following treatment. When this occurs NAATs should be performed for urethritis pathogens including *T. vaginalis* four weeks after completion of therapy [305, 322].

3.10.5 Disease management

For severe urethritis empirical treatment should be started following diagnosis. If the patients symptoms are mild, delayed treatment guided by the results of NAATs is recommended. All sexual partners at risk should be assessed and treated whilst maintaining patient confidentiality [305, 325].

3.10.5.1 Gonococcal urethritis

For GU, a combination treatment using two antimicrobials with different mechanisms of action is recommended to improve treatment efficacy and to hinder increasing resistance to cephalosporins [306]. Ceftriaxone 1 g intramuscularly or intravenously with azithromycin 1 g single oral dose should be used as first-line treatment. Azithromycin is recommended because of its favourable susceptibility rates compared to other antimicrobials, good compliance with the single-dose regimen and the possibility of a *C. trachomatis* co-infection [306]. In case of azithromycin allergy, doxycycline can be used instead in combination with ceftriaxone or cefixime [306]. A 400 mg oral dose of cefixime is recommended as an alternative regimen to ceftriaxone; however, it has less favourable pharmacodynamics and may lead to the emergence of resistance [307, 343].

A number of alternative regimens for the treatment of GU have been studied. In a randomised, open label, non-comparative clinical study dual treatment with a combination of intramuscular gentamicin 240 mg plus oral azithromycin 2 g (n=202) single doses and a combination of oral gemifloxacin 320 mg plus oral azithromycin 2 g (n=199) single doses were associated with microbiological cure rates of 100% and 99.5%, respectively [339]. A 2014 systematic review focusing on the use of single-dose intramuscular gentamicin concluded that there is insufficient data to support or refute the efficacy and safety of this regimen in the treatment of uncomplicated gonorrhoea [313]. In three prospective single arm studies enrolling men with GU the use of extended-release azithromycin 2 g single oral dose resulted in microbiological cure rates of 83% (n=36), 93.8% (n=122) and 90.9% (n=33), respectively [329, 330, 332]. However, azithromycin monotherapy is generally not recommended because of its effect on increasing macrolide resistance rates [306]. Intramuscular spectinomycin 2 g single dose shows microbiological cure rates above 96% [340, 343] in urogenital gonorrhoeal infections; therefore, where available, it can be a valid treatment alternative. An open label, randomised trial compared oral fosfomicin trometamol 3 g

on days one, three and five (n=60) with intramuscular ceftriaxone 250 mg plus oral azithromycin 1 g single dose (n=61) in men with uncomplicated GU. In the per-protocol analysis clinical and microbiologic cure rates were 96.8% and 95.3% respectively [333].

The worldwide increase in gonorrhoeal antimicrobial resistance and the emergence of multidrug-resistant gonorrhoeal strains is a globally recognised healthcare crisis which emphasises the importance of guideline adherence [312, 324, 344].

3.10.5.2 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. Alternatively, single dose oral azithromycin 500 mg day one and 250 mg days two to four can be used. This regimen provides better efficacy compared to azithromycin 1 g single dose for *M. genitalium* infections, in which azithromycin 1 g single dose treatment is associated with the development of increasing macrolide resistance significantly decreasing the overall cure rate [305, 308, 314, 328]. However, a retrospective cohort study did not find significant difference between the extended and 1 g single dose azithromycin regimen regarding cure rates and the selection of macrolide resistance in *M. genitalium* urethritis [326]. If macrolide resistant *M. genitalium* is detected moxifloxacin 400 mg can be used for seven to fourteen days [305, 306, 315]. In case of failure after both azithromycin and moxifloxacin treatment, pristinamycin (registered in France) is the only antimicrobial agent with documented activity against *M. genitalium* [308, 327, 338]. Josamycin 500 mg three times a day for ten days is used in Russia, but will not eradicate macrolide-resistant strains [308].

For chlamydial urethritis azithromycin 1 g single dose and doxycycline 100 mg twice daily for seven days are both effective options [342]. A Cochrane Review found that in men with urogenital *C. trachomatis* infection regimens with azithromycin are probably less effective than doxycycline for microbiological failure, however, there might be little or no difference for clinical failure [316]. Fluoroquinolones, such as ofloxacin or levofloxacin, may be used as second-line treatment only in selected cases where the use of other agents is not possible [341].

For *U. urealyticum* infections the efficacy of doxycycline 100 mg twice daily for seven days is similar to azithromycin 1 g single dose treatment [305, 323]. For urethritis caused by *T. vaginalis* oral metronidazole or tinidazole 2 g single dose is recommended as first-line treatment. For treatment options for persistent or recurrent *T. vaginalis* infection refer to the review of Sena *et. al* [311].

In case of persistent NGU treatment should cover *M. genitalium* and *T. vaginalis* [305, 306].

3.10.6 Follow-up

Patients should be followed up for control of pathogen eradication after completion of therapy only if therapeutic adherence is in question, symptoms persist or reoccurrence is suspected. Patients should be instructed to abstain from sexual intercourse for seven days after therapy is initiated, provided their symptoms have resolved and their sexual partners have been adequately treated. Reporting and source tracing should be done in accordance with national guidelines and in cooperation with specialists in venereology, whenever required. Persons who have been diagnosed with a new STD should receive testing for other STDs, including syphilis and HIV [310].

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 ($\times 1,000$) 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 <i>C. trachomatis</i> infection in men azithromycin is probably less effective than doxycycline for microbiological failure, however, there might be little or no difference for clinical failure.	1a
In case of <i>U. urealyticum</i> infection the efficacy of doxycycline 100 mg twice for seven days is similar to azithromycin 1 g 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
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 maintaining patient confidentiality.	Strong

Table 8: Suggested regimens for antimicrobial therapy for urethritis

Pathogen	Antimicrobial	Dosage & Duration of therapy	Alternative regimens
Gonococcal Infection	Ceftriaxone Azithromycin	1 g i.m. or i.v.*, SD 1 g p.o., SD	<ul style="list-style-type: none"> Cefixime 400 mg p.o., SD <u>plus</u> Azithromycin 1 g p.o., SD <p>In case of cephalosporin allergy:</p> <ul style="list-style-type: none"> Gentamicin 240 mg i.m SD <u>plus</u> Azithromycin 2 g p.o., SD Gemifloxacin 320 mg p.o., SD <u>plus</u> Azithromycin 2 g p.o., SD Spectinomycin 2 g i.m., SD Fosfomycin trometamol 3 g p.o. on days 1, 3 and 5 <p>In case of azithromycin allergy, in combination with ceftriaxone or cefixime:</p> <ul style="list-style-type: none"> Doxycycline 100 mg b.i.d, p.o., 7 days
Non-Gonococcal infection (non-identified pathogen)	Doxycycline	100 mg b.i.d, p.o., 7 days	Azithromycin 500 mg p.o., day 1, 250 mg p.o., 4 days
<i>Chlamydia trachomatis</i>	Azithromycin <u>Or</u> Doxycycline	1.0-1.5 g p.o., SD 100 mg b.i.d, p.o., for 7 days	<ul style="list-style-type: none"> Levofloxacin 500 mg p.o., q.d., 7 days Ofloxacin 200 mg p.o., b.i.d., 7 days
<i>Mycoplasma genitalium</i>	Azithromycin	500 mg p.o., day 1, 250 mg p.o., 4 days	In case of macrolide resistance: <ul style="list-style-type: none"> Moxifloxacin 400 mg q.d., 7-14 days
<i>Ureaplasma urealyticum</i>	Doxycycline	100 mg b.i.d, p.o., 7 days	Azithromycin 1.0-1.5 g p.o., SD
<i>Trichomonas vaginalis</i>	Metronidazole Tinidazole	2 g p.o., SD 2 g p.o., SD	Metronidazole 500 mg p.o., b.i.d., 7 days
Persistent non-gonococcal urethritis			
After first-line doxycycline	Azithromycin <u>plus</u> Metronidazole	500 mg p.o., day 1, 250 mg p.o., 4 days 400 mg b.i.d. p.o., 5 days	If macrolide resistant <i>M. genitalium</i> is detected moxifloxacin should be substituted for azithromycin

After first-line azithromycin	Moxifloxacin	400 mg p.o. q.d., 7-14 days	
	plus Metronidazole	400 mg b.i.d. p.o., 5 days	

SD = single dose; b.i.d = twice daily; q.d = everyday; p.o. = orally; i.m. = intramuscular; i.v. = intravenous.

* 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 [345].

3.11 Bacterial Prostatitis

3.11.1 Introduction

Bacterial prostatitis is a clinical condition caused by bacterial pathogens. It is recommended that urologists use the classification suggested by the National Institute of Diabetes, Digestive and Kidney Diseases (NIDDK) of the National Institutes of Health (NIH), in which bacterial prostatitis, with confirmed or suspected infection, is distinguished from chronic pelvic pain syndrome (CPPS) (Table 9) [346-348].

Table 9: Classification of prostatitis and CPPS according to NIDDK/NIH [346-348]

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 until June 2017 was performed. One systematic review [349], six RCTs [350-355], two narrative reviews [356, 357], one prospective cohort study [358], two prospective cross-sectional studies [359, 360], and one retrospective cohort study [352], were selected from 856 references.

A retrospective study [361], 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 [359, 360]. The evidence levels were good, in particular those regarding information on atypical strains, epidemiology and antibiotic treatments.

A systematic review on antimicrobial therapy for CBP [349] 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 [354, 355] 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 [356] 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 different 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* [353]. Metronidazole 500 mg three times daily for fourteen days was found to be efficient for micro-organism eradication in 93.3% of patients with clinical failure in 3.33% of cases. The evidence question addressed was: In men with NIDDK/NIH Category I or II prostatitis what is the best antimicrobial treatment strategy for clinical resolution and eradication of the causative pathogen?

3.11.3 **Epidemiology, aetiology and pathogenesis**

Prostatitis is a common diagnosis, but less than 10% of cases have proven bacterial infection [228]. *Enterobacteriales*, especially *E. coli*, are the predominant pathogens in ABP [362]. In CBP, the spectrum of species is wider and may include atypical micro-organisms [356]. 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* [363]. The significance of identified intracellular bacteria, such as *C. trachomatis*, is uncertain [364]; however, two studies have highlighted its possible role as a causative pathogen in CBP [365, 366].

3.11.4 **Diagnostic evaluation**

3.11.4.1 *History and symptoms*

Acute bacterial prostatitis usually presents abruptly with voiding symptoms and distressing but poorly localised pain. It is often associated with malaise and fever. Transrectal prostate biopsy increases the risk of ABP despite antibiotic prophylaxis and antiseptic prevention procedures [350]. Chronic bacterial prostatitis is defined by symptoms that persist for at least three months [367-369]. The predominant symptoms are pain at various locations including the perineum, scrotum, penis and inner part of the leg as well as LUTS [346-348].

3.11.4.2 *Symptom questionnaires*

In CBP symptoms appear to have a strong basis for use as a classification parameter [370]. Prostatitis symptom questionnaires have therefore been developed to assess severity and response to therapy [370, 371]. They include the validated Chronic Prostatitis Symptom Index (CPSI); however, its usefulness in clinical practice is uncertain [358].

3.11.4.3 *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% [372]. Blood culture and complete blood count are useful in ABP. Imaging studies can detect a suspected prostatic abscess [356].

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 men in endemic regions or with a history of tuberculosis should trigger investigation for urogenital tuberculosis.

3.11.4.4 *Urine cultures and expressed prostatic secretion*

The most important investigation in the evaluation of a patient with ABP is mid-stream urine culture [356]. In CBP, quantitative bacteriological localisation cultures and microscopy of the segmented urine and expressed prostatic secretion (EPS), as described by Meares and Stamey [373], are still important investigations to categorise clinical prostatitis [359, 360]. 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* [361]. The two-glass test has been shown to offer similar diagnostic sensitivity to the four-glass test [374].

3.11.4.5 *Prostate biopsy*

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

3.11.4.6 *Other tests*

Transrectal US may reveal endoprostatic abscesses, calcification in the prostate, and dilatation of the seminal vesicles; however, it is unreliable as a diagnostic tool for prostatitis [375].

3.11.4.7 Additional investigations

3.11.4.7.1 Ejaculate analysis

Performing an ejaculated semen culture improves the diagnostic utility of the four-glass test [359]; however, semen cultures are more often positive than EPS cultures in men with non-bacterial prostatitis [360]. Bladder outflow and urethral obstruction should always be considered and ruled out by uroflowmetry, retrograde urethrography, or endoscopy.

3.11.4.7.2 First-void urine sample

First-void urine is the preferred specimen for the diagnosis of urogenital *C. trachomatis* infection in men by NAATs, since it is non-invasive and yet allows the detection of infected epithelial cells and associated *C. trachomatis* particles [376].

3.11.4.7.3 Prostate specific antigen (PSA)

Prostate specific antigen is increased in about 60% and 20% of men with ABP and CBP, respectively [357]. The PSA level decreases after antibiotic therapy (which occurs in approximately 40% of patients) and correlates with clinical and microbiological improvement [351]. Measurement of free and total PSA adds no practical diagnostic information in prostatitis [377].

3.11.4.8 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 <i>C. trachomatis</i> 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%; therefore, it is 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 mid-stream urine dipstick to check nitrite and leukocytes in patients with clinical suspicion of ABP.	Weak
Take a mid-stream 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 <i>Chlamydia trachomatis</i> or <i>Mycoplasma</i> 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

3.11.5.1 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 [378]. For initial therapy, any of these antimicrobials may be combined with an aminoglycoside [362-371, 378-382]. 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 [383].

Fluoroquinolones, despite the high resistance rates of uropathogens, are recommended as first-line agents in the empirical treatment of CBP because of their favourable pharmacokinetic properties [384], their generally good safety profile and antibacterial activity against Gram-negative pathogens including *P. aeruginosa* and *C. trachomatis* [349, 385]. However, increasing bacterial resistance is a concern. Azithromycin and doxycycline are active against atypical pathogens such as *C. trachomatis* and genital mycoplasmas [352, 361]. Levofloxacin did not demonstrate significant clearance of *C. trachomatis* in patients with CBP [386]. Metronidazole treatment is indicated in patients with *T. vaginalis* infections [353].

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 [352, 361]. In CBP antimicrobials should be given for four to six weeks after initial diagnosis [356]. If intracellular bacteria have been detected macrolides or tetracyclines should be given [349, 384, 387].

3.11.5.2 Intraprostatic injection of antimicrobials

This treatment has not been evaluated in controlled trials and should not be considered [388, 389].

3.11.5.3 Combined treatments

A combination of fluoroquinolones with various herbal extracts may attenuate clinical symptoms without increasing the rate of adverse events [354]. 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 [355].

3.11.5.4 Drainage and surgery

Approximately 10% of men with ABP will experience urinary retention [390] which can be managed by urethral or suprapubic catheterisation. However, recent evidence suggests that suprapubic catheterisation can reduce the risk of development of CBP [391].

In case of prostatic abscess, both drainage and conservative treatment strategies appear feasible [392]; however, the abscess size may matter. In one study, conservative treatment was successful if the abscess cavities were < 1 cm in diameter, while larger abscesses were better treated by single aspiration or continuous drainage [393].

3.11.5.5 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 confirmed 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 500 mg three times daily for fourteen days was found to be efficient for eradication in 93.3% of patients with <i>T. vaginalis</i> 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	
Treat acute bacterial prostatitis according to the recommendations for complicated UTIs (see section 3.7.5).	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 <i>T. vaginalis</i> 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	100 mg b.i.d	10 days	Only for <i>C. trachomatis</i> or mycoplasma infections
Azithromycin	500 mg once daily	3 weeks	Only for <i>C. trachomatis</i> infections
Metronidazole	500 mg t.i.d.	14 days	Only for <i>T. vaginalis</i> infections

b.i.d = twice 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 [356]. 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 [356].

3.12 Acute Infective 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 [394]. Acute epididymitis is clinically characterised by pain, swelling and increased temperature of the epididymis, which may involve the testis and scrotal skin. It is generally caused by migration of pathogens from the urethra or bladder that can be identified by appropriate diagnostics in up to 90% of patients [395]. Torsion of the spermatic cord (testicular torsion) is the most important differential diagnosis in boys and young men.

The predominant pathogens isolated are *Enterobacterales* (typically *E. coli*), *C. trachomatis* and *N. gonorrhoeae* [396]. Men who have anal intercourse and those with abnormalities of the urinary tract resulting in bacteriuria are at higher risk of epididymitis caused by *Enterobacterales* [397]. The mumps virus should be considered if there are viral prodromal symptoms and salivary gland enlargement. Tuberculous epididymitis may occur, typically as chronic epididymitis, in high-risk groups such as men with immunodeficiency and those from high prevalence countries, it frequently results in a discharging scrotal sinus. *Brucella* or *Candida spp.* are rare possible pathogens.

3.12.2 Diagnostic Evaluation

Culture of a mid-stream 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 NAAT on first voided urine or urethral swab. A urethral swab or smear should be performed for Gram staining and culture of *N. gonorrhoeae*, when available [394, 398, 399]. Detection of these pathogens should be reported according to local procedures. All patients with probable sexually transmitted infections (STIs) should be advised to attend an appropriate clinic to be screened for other STIs. Men 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 [400]. 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 [401] and may also be beneficial for the exclusion of other pathologies [402].

3.12.3 Disease Management

Men with suspected STI should be informed of the risks to others and advised not to have sex until free of infection. Empirical antimicrobial therapy has to 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 some specific 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 [403]. 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 high parenteral dose of a third-generation cephalosporin is effective against *N. gonorrhoeae*; current resistance patterns and local public health recommendations should guide choice of agent.

Clinical response to antibiotics in men with severe epididymitis should be assessed after approximately three days. Men with likely or proven STI should be assessed at fourteen days to check cure and ensure tracing and treatment of contacts according to local public health recommendations.

3.12.4 Evidence Summary

Relating to this chapter, four guidelines based on systematic reviews were identified [306, 398, 404, 405]. 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 [406]. 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 [395].

Empiric antibiotic regimens from existing guidelines [306, 398, 404, 405] and panel consensus:

1. For men with acute epididymitis at low risk of gonorrhoea (e.g. no discharge) a single agent or combination of two agents of sufficient dose and duration to eradicate *C. trachomatis* and *Enterobacterales* should be used. Appropriate options are:
 - A. A fluoroquinolone active against *C. trachomatis* orally once daily for ten to fourteen days*
 - OR**
 - B. Doxycycline 200 mg initial dose by mouth and then 100 mg twice daily for ten to fourteen days* **plus** an antibiotic active against *Enterobacterales*** for ten to fourteen days*
2. For men with likely gonorrhoeal acute epididymitis a combination regimen active against *Gonococcus* and *C. trachomatis* must be used such as:
 - A. Ceftriaxone 1000 mg intramuscularly single dose **plus** doxycycline 200 mg initial dose by mouth and then 100 mg twice daily for ten to fourteen days*
3. For non-sexually active men with acute epididymitis a single agent of sufficient dose and duration to eradicate *Enterobacterales* should be used. Appropriate option is a fluoroquinolone by mouth once 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 US may predict requirement for surgery following initial antibiotic treatment [407].

A cohort study found semen parameters may be impaired during epididymitis but recovered following successful treatment [408]. Comparative clinician cohort studies suggest adherence to guidelines for assessment and treatment of epididymitis is low, particularly by urologists compared to sexual health specialists [409] and by primary care physicians [410].

3.12.5 Screening

A large cohort screening study for carriage of *C. trachomatis* including a randomly selected group of 5,000 men of whom 1,033 were tested showed no benefit in terms of reduction in risk of epididymitis over nine years of observation [411].

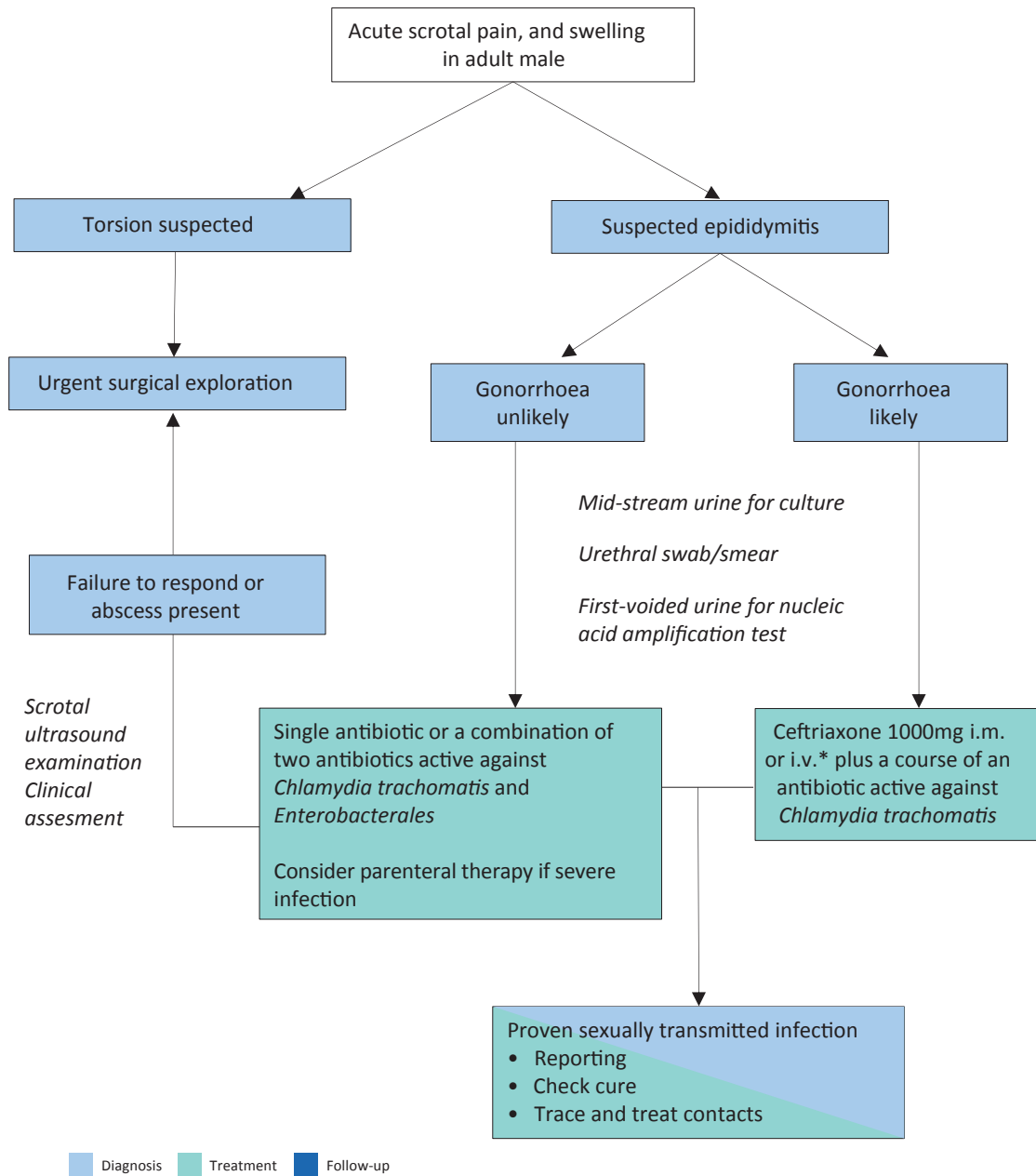
3.12.6 **Summary of evidence and recommendations for the diagnosis and treatment of acute infective epididymitis**

Summary of evidence	LE
In young sexually active patients both STIs and Enterobacterales have to 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 <i>Chlamydia trachomatis</i> 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 1000 mg intramuscularly or intravenously* in addition to a course of an antibiotic active against <i>Chlamydia trachomatis</i> .	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 [345].*

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 [345].

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, peri-anal region, and external genitalia [412]. It is an anatomical sub-category of necrotising fasciitis with which it shares a common aetiology and management pathway.

3.13.2 Diagnostic Evaluation

Typically, there is painful swelling of the scrotum or perineum with sepsis [412]. 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, 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 [413]. A high index of suspicion and careful examination, particularly of obese patients, is required. Computed tomography or MRI can help define para-rectal involvement, suggesting the need for bowel diversion [412].

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 necessary to reduce mortality [412]. 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 [412]. Immediate empiric parenteral antibiotic treatment should be given that covers all probable causative organisms and can penetrate inflammatory tissue. A suggested regime would comprise a broad-spectrum penicillin or third-generation cephalosporin, gentamicin and metronidazole or clindamycin [412]. 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 640 references one RCT [414], two systematic reviews [415, 416], one narrative review [412], three registry studies [417-419], one prospective cohort study [420] and two retrospective comparative cohort studies with at least 25 patients [421, 422] were selected. The three registry studies from the United States [417-419], 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 [420]. 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 there any effective adjuvant treatments that improve outcome?

Concerning the evidence questions:

- A. A low-quality retrospective case series [421] 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 [416] found low-quality evidence from 16 case series involving 425 male patients. They recommended primary or secondary wound closure for scrotal defects $\leq 50\%$ with 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 [415] 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 [422] 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 [414] with 30 patients found that 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% with 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 dressing soaked with 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 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 [423].

Antimicrobial	Dosage
Piperacillin-tazobactam <u>plus</u> Vancomycin	4.5 g every 6-8 h IV 15 mg/kg every 12 h
Imipenem-cilastatin	1 g every 6-8 h IV
Meropenem	1 g every 8 h IV
Ertapenem	1 g once daily
Gentamicin	5 mg/kg daily
Cefotaxime <u>plus</u> metronidazole or clindamycin	2 g every 6 h IV 500 mg every 6 h IV 600-900 mg every 8 h IV
Cefotaxime <u>plus</u> fosfomycin <u>plus</u> metronidazole	2 g every 6 h IV 5 g every 8 h IV 500 mg every 6 h IV

IV = intravenous.

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. HPV 16 is the most common oncogenic variant, detected in 20% of all HPV cases [424]. A recent meta-analysis revealed a prevalence of 49% of any type of HPV and 35% of high-risk HPV in men [425]. Similar to the female genital tract, half of all HPV infections in the male genital tract are co-infections (≥ 2 HPV strains) [426].

HPV presence is dependent on study setting. In men attending urological clinics HPV was detected in 6% of urine samples [427]. A meta-analysis reported seminal HPV in 4.5-15.2% of patients resulting in seminal HPV being associated with decreased male fertility [424]. A cross sectional study of 430 men presenting for fertility treatment detected HPV in 14.9% of semen samples [428]. The presence of HPV in semen was not associated with impaired semen quality [428]. 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 [429]. 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 [430]. The incidence of non-oncogenic HPV infection has been shown to be higher in men than women [431]. In males, approximately 33% of penile cancers and up to 90% of anal cancers are attributed to high-risk HPV infections, primarily with HPV16 [432]. The EAU Penial Cancer Guidelines will publish a comprehensive update in March 2022 including the results of two systematic reviews on HPV and penile cancer. 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 [432]. Systematic reviews have reported prevalence rates of oral HPV from 5.5-7.7%, with HPV16 present in 1-1.4% of patients [433, 434].

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 [435-439]. Incidence and prevalence of overall HPV was considerably higher in MSM compared to heterosexuals [433, 436]. Overall, the prevalence of HPV in different sites seems to be higher in young, sexual-active adults compared to other population groups [435]. Stable sexual habits, circumcision and condom use are protective factors against HPV [425, 439-443]. Added risk factors of oral HPV infection are alcohol consumption, poor oral hygiene and sexual behaviours (oral and vaginal) [433, 435]. Positive HIV status, phimosis, and HPV status of the partner have also been associated with anogenital HPV status and decreased clearance in a number of studies [440].

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 route [437]. In addition, HPV has been found on surfaces in medical settings and public environments raising the possibility of object-to-skin/mucosa transmission [444]. 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 [437].

3.14.4 **Clearance**

HPV time-to-clearance ranges from 1.3 to 42.1 months [445]. Clearance may be influenced by HPV genotype, patients' characteristics and affected body site [436, 440, 445]. HPV 16 has the highest incidence of high-risk HPV variants and has the lowest clearance across sites [440].

3.14.5 **Diagnosis**

There is currently no approved test for HPV in men. Routine testing to check for HPV or HPV-related disease in men is not recommended. A physical examination to identify HPV lesions should be carried out. An acetic acid test to diagnose sub-clinical HPV lesions may be performed. If the diagnosis is uncertain or there is a suspicion of cancer a biopsy should be carried out. Intra-urethral condylomas are relatively uncommon and are usually limited to the distal urethral meatus [446, 447]. Urethrocystoscopy may be used to diagnose the presence of intra-urethral or bladder warts [447]; however, there is no high-level evidence for the use of invasive diagnostic tools for localisation of intra-urethral HPV. For detailed recommendations on the diagnosis of anogenital warts please refer to the IUSTI-European guideline for the management of anogenital warts [448].

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 2 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 [448]. Of the treatment options available only surgical treatment has a primary clearance rate approaching 100%.

3.14.6.1 *Treatments suitable for self-application*

Patient-applied treatments include podophyllotoxin, salicylic acid, imiquimod, polyphenon E, 5-fluoracil and potassium hydroxide [448]. Imiquimod 5% cream showed a total clearance of external genital or perianal warts in 50% of immunocompetent patients [449] as well as in HIV positive patients successfully treated with highly active antiretroviral therapy [450]. 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) [451]. The recommended treatment schedule is imiquimod 5% cream applied to all external warts overnight 3 times each week for 16 weeks [448]. 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 vs. 33.7% for placebo [452]. In addition, sinecatechins 10% has been shown to be associated with lower short-term recurrence rates when used as sequential therapy after laser CO2 ablative therapy [453].

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 [448]. 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) [454]. Podophyllotoxin is self-applied to lesions twice daily for 3 days, followed by four rest days, for up to 4 or 5 weeks. An RCT has also shown potassium hydroxide 5% to be an effective, safe, and low-cost treatment modality for genital warts in men [455].

3.14.6.2 Physician-administered treatment

3.14.6.2 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) [456, 457]. 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 [456, 457]. No data about 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 [458].

3.14.6.3 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 vs. 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 therapy, 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 3 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 3 days, followed by four rest days, for up to 4 or 5 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 which has been shown to reduce the incidence of sexually transmitted infections including HIV, syphilis and HSV-2 [459]. Two systematic reviews and meta-analyses, showed an inverse association between male circumcision and genital HPV prevalence in men [443, 445]. 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 men and women, particularly among those countries in which HPV vaccination programs and cervical screening are not available [445].

Summary of evidence	LE
Two systematic reviews and meta-analyses, showed an inverse association between male circumcision and genital HPV prevalence in men	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

Three different vaccines against HPV have been licensed to date, but routine vaccination of males is currently implemented in only a few countries including Australia, Canada, the USA and Austria¹⁶. The aim of male vaccination is to reduce the rate of anal and penile cancers as well as head and neck cancers [432, 460].

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 [432]. 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 [432].

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 [461]. 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

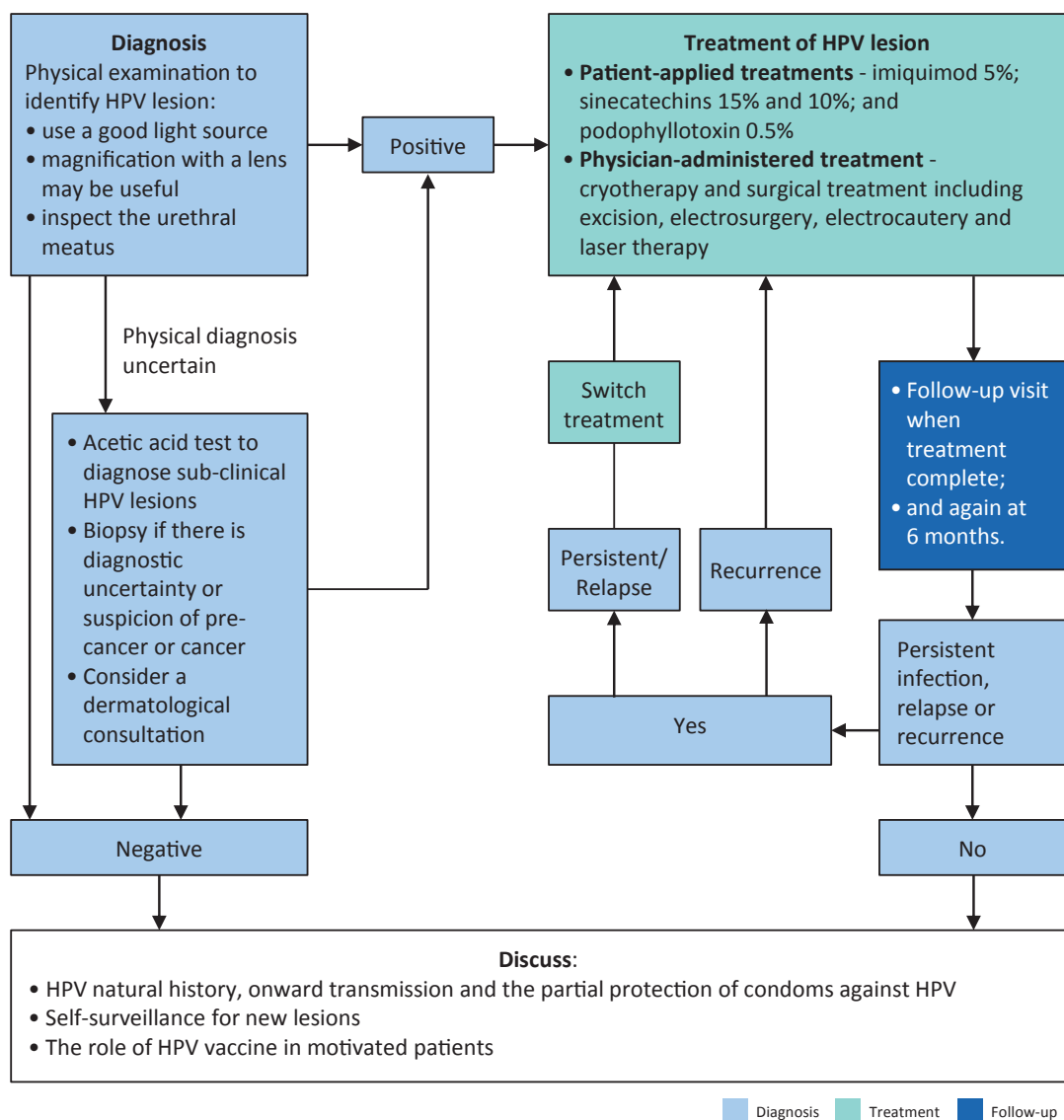
A systematic review and meta-analysis reported that vaccination is moderately effective against genital HPV-related diseases irrespective of an individual's HPV status; however, higher vaccine efficacy was observed in HPV-naïve males [432]. Supporting the early vaccination of boys with the goal of establishing optimal vaccine-induced protection before the onset of sexual activity [432]. An RCT including 1,124 demonstrated high efficacy of the quadrivalent HPV vaccine vs. placebo against HPV6/11/16/18-related persistent infections [462]. Furthermore, the vaccine elicited a robust immune response and was well tolerated with mild vaccination-related adverse events e.g. injection-site pain and swelling [462]. 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 [463].

Despite the fact quadrivalent HPV vaccines were approved for use in young adult males in 2010 vaccination rates have remained low at 10-15% [464]. 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 [464]. Health care professionals should provide easily understood and accessible communication resources regarding these issues, in order to educate young adult males and their families on the importance of HPV vaccination to reduce the incidence of certain cancers in the later life [464, 465].

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 a 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 in order to improve HPV vaccination knowledge in young adult males.	Strong

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



3.15 Genitourinary Tuberculosis

3.15.1 *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 [466]. An estimated 12.0% of incident TB cases in 2019 were co-infected 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 than non-migrants. Genitourinary tuberculosis (GUTB) accounted for 4.6% of extrapulmonary TB cases in the EU between 1997-2017 [467]. Tuberculosis is an infectious disease caused by a group of *Mycobacterium* species called the *Mycobacterium tuberculosis* complex (MTC) [468]. Genitourinary TB can affect all genitourinary organs and is almost always secondary due to the hematogenous spread of chronic latent TB infection (LTBI) [469]. Risk factors include primary and LTBI, 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 [470]. The WHO recommend either a tuberculin skin test (TST) or interferon-gamma release assay (IGRA) for the diagnosis LTBI [471].

3.15.2 *Diagnosis*

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. 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.

3.15.2.1 *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 [472, 473]. A major limitation of smear microscopy is its low sensitivity (ranging from 0-25%) in urine [474, 475].

3.15.2.2 *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 [473]. A disadvantage of culture-based methods is the long incubation period needed for results at least 9–10 days for positive results and 6 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 [476, 477].

3.15.2.3 *Nucleic Acid Amplification Tests*

In recent years, nucleic acid amplification tests (NAATs) have been introduced in the diagnostic pathway of TB, to overcome the limits of early and rapid diagnosis and of drug susceptibility testing. 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 the initial diagnostic test [478]. Xpert MTB/RIF pooled sensitivity and specificity were 84.7% (70.8 to 93.1) and 97.3% (91.0 to 99.2) for the diagnosis of genitourinary TB [479]. The 2021 WHO guidelines also contain a number of recommendations for additional PCR testing systems as well as moderate complexity automated NAATs [478].

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

3.15.2.4 *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 genito-urinary system. Imaging techniques for the diagnosis of GUTB have a sensitivity of approx. 90% [480]. However, the quality of the evidence available for diagnostic imaging of TB is low to very-low and further studies are required to allow 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 [481-485]. 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 [486]. In female GUTB patients US may identify ovarian masses, intrauterine thickening and calcifications [487].

Intravenous urography aids in the identification of renal and ureteral TB, but lacks specificity. Approximately 10-15% of patients may have normal findings on IVU [488, 489]. The most common findings on IVU are hydrocalycosis, hydronephrosis or hydroureter due to stricture, autonephrectomy and urinary calcifications [490-492].

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 [490-492]. 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 [493, 494]. Prostate TB appears as a low attenuating and marginally enhancing cystic mass, which is indistinguishable from a non-TB prostatic abscess [495]. In female GUTB the fallopian tubes are most frequently affected area and present with enlargement, hydrosalpinx, pyosalpinx, and wall thickening, with calcification on CT [496].

Magnetic resonance imaging has low sensitivity for the diagnosis of GUTB in the early stages of the infection [497]. 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 [487, 498]. Epididymitis and testicular TB appears as a diffusely enlarged epididymis or testis with heterogeneous high T2 signal due to fibrosis and calcification [494]. Multiparametric MRI of the prostate distinguishes between the nodular or diffuse patterns of prostate TB [499].

Female GUTB has a wide range of appearances on HSG affecting the fallopian tubes, endometrium and uterus [500, 501]. Tubal obstruction is the most common finding with HSG [501]. In addition, deformity of the uterine cavity can be observed, such as a T-shaped and Dwarfed uterus, resulting from abnormal scarring and fibrosis [500]. As the disease progresses this process can potentially lead to a complete obliteration of the uterine cavity referred to as Netter syndrome [502].

3.15.3 **Medical Treatment**

The WHO recommends a daily six month 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 [503]. For the treatment of multi-drug resistant (MDR) TB (i.e. resistance to rifampicin and isoniazid) an individualised treatment regime should be applied with at least five effective tuberculosis medicines during the intensive phase, including pyrazinamide and four core second-line tuberculosis medicines [504].

3.15.4 **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 [505-507]. In 26.9% of cases of diagnosed GUTB there is a non-functioning unilateral kidney and in 7.4%, renal failure [507].

In the largest observational study of 4,288 GUTB patient's a total of 2,364 different surgical procedures were carried out of which 948 were reconstructive [508]. In a retrospective series of 241 patients who underwent surgery for GUTB, a total of 128 reconstructive procedures were done in which 30.29% of patients had bladder augmentation [509]. A retrospective single-centre study of 128 patients reported renal units in the reconstruction group had 5.44-fold longer survival than the permanent diversion group suggesting that when feasible renal reconstruction may be better for renal function preservation [510]. Reconstructive surgery may include augmentation cystoplasty, uretero-ureterostomy, ureteroneocystostomy, ureteral reimplant, pyeloplasty, ureterocalicostomy and ileal ureter or external diversion, where indicated [511].

There is limited evidence with regard to the optimum surgical approach. Minimally invasive options, have been reported as feasible and safe strategies, comparable to open surgery [512-516]. In addition, the optimal timing for surgery is controversial. A delay of 2-6 weeks up to 9 months after the initiation of medical treatment has been proposed to allow for a reduction in active inflammation and stabilisation of the TB lesions [497].

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

3.15.5 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 0-25%.	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 to 93.1) and 97.3% (91.0 to 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 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, discharged or prostatic massage fluid using Ziehl–Neelsen (ZN) or auramine staining in patients with suspected genitourinary tuberculosis (GUTB).	Weak
Perform acid-fast bacilli culture on three midstream first-void urine samples, on three consecutive days for <i>M. tuberculosis</i> isolation in patients with suspected GUTB.	Strong
Use a recommended PCR test systems in addition to 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 multi-drug resistant TB with an individualised treatment regime including at least five effective tuberculosis medicines during the intensive phase, including pyrazinamide and four core second-line tuberculosis medicines.	Strong

Table 12: Treatment regimens for newly diagnosed GUTB and MDR-TB [504]

Antimicrobials	Dosage
Six month regimen for treatment of newly diagnosed GUTB	
Intensive two month phase	
Isoniazid	5 mg/kg every 24 h; max daily dosage 300 mg
Rifampicin	10 mg/kg every 24 h; max daily dosage 600 mg
Pyrazinamide	25 mg/kg every 24 h; max daily dosage 2000 mg
Ethambutol	15–20 mg/kg every 24 h; max daily dosage ranging from 800 mg to 1600 mg depending on body weight
Continuation four month phase	
Isoniazid	5 mg/kg every 24 h; max daily dosage 300 mg
Rifampicin	10 mg/kg every 24 h; max daily dosage 600 mg

Treatment regimen for multi-drug resistant TB	
Treat multi-drug resistant TB with an individualised treatment regime 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 regime)	D1: Pyrazinamide, Ethambutol, and High-dose isoniazid D2: Bedaquiline and Delamanid D3: p-aminosalicylic acid, Imipenem-cilastatin, Meropenem, Amoxicillin-clavulanate and Thioacetazone***

* Drugs should be chosen as follows: 1 from group A, 1 from group B, and at least 2 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 may be added to bring the total to five [504].

**Streptomycin can substitute other injectable drugs if none of these agents can be used and if the strain is shown not to be resistant [504].

***Thioacetazone should not be used if the patient is HIV seropositive [504].

3.16 Peri-Procedural Antibiotic Prophylaxis

3.16.1 General Principles

3.16.1.1 Definition of infectious complications

The European Centre for Disease Prevention and Control (ECDC) and the CDC have both presented similar definitions recommended for the evaluation of infectious complications [517, 518].

3.16.1.2 Non-antibiotic measures for asepsis

There are a number of non-antibiotic measures designed to reduce the risk of surgical site infection (SSI), many 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 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 hand washing [519], 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 pre-operatively, but use of chlorhexidine soap does not appear to be beneficial [520]. Although evidence quality is low, any required hair removal appears best done by clipping, rather than shaving, just prior to incision [521]. Mechanical bowel preparation should not be used as evidence review suggests harm not benefit [522, 523]. There is some weak evidence that skin preparation using alcoholic solutions or chlorhexidine result in a lower rate of SSI than iodine solutions [524]. Studies on the use of plastic adherent drapes showed no evidence of benefit in reducing SSI [525].

3.16.1.3 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 pre-operative 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 different index tests (dipstick, automated microscopy, dipslide culture and flow cytometry), with urine culture as the reference standard [526]. 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 [526].

3.16.1.4 Choice of agent

Urologists should have knowledge of local pathogen prevalence for each type of procedure, their antibiotic susceptibility profiles and virulence in order to establish written local guidelines. These guidelines should cover the five modalities identified by the ECDC following a systematic review of the literature [527]. 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 > 20 mL/min; second generation cephalosporins are an alternative [528]. Recent urine culture results including presence of any multi-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 as there is considerable variation in Europe and worldwide regarding bacterial pathogens, their susceptibility and availability of antibiotic agents.

3.16.2 **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 post-operative symptomatic UTI in patients undergoing each named procedure?

3.16.2.1 *Urodynamics*

The literature search identified one systematic review for antibiotic prophylaxis in women only [529]. This included 3 RCTs (n=325 patients) with the authors reporting that prophylactic antibiotics reduced the risk of bacteriuria but not clinical UTI after urodynamics [529]. A previous Cochrane review identified nine RCTs enrolling 973 patients with overall low quality and high or unclear risks of bias [530]. The outcome of clinical UTI was reported in four trials with no benefit found for antibiotic prophylaxis vs. placebo [RR (95%CI) 0.73 (0.52-1.03)]. A meta-analysis of nine trials showed that use of antibiotics reduced the rate of post-procedural bacteriuria [RR (95%CI) 0.35 (0.22-0.56)] [530].

3.16.2.2 *Cystoscopy*

Three systematic reviews and meta-analyses [531-533] and one additional RCT [534] 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 [532]. 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 [531]. 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)] [533]. 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 post-procedural 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 urethroscopy (flexible or rigid).

3.16.2.3 *Interventions for urinary stone treatment*

3.16.2.3.1 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 [535, 536] and two further trials [537]. 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 post-procedural fever or bacteriuria [535]. 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 [536]. A 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 500 mg and no difference in the rate of bacteriuria [537]. 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 200 mg ofloxacin post-operatively for 3-days vs. placebo [538].

For patients with bacteriuria or deemed at high risk of complications one RCT comparing the use of ofloxacin or trimethoprim-sulphamethoxazole for three days prior and four days subsequent to ESWL in 56 patients with ureteric stents was identified [539]. They found no difference in rate of clinical UTI at seven days (no events) and no difference in post-ESWL bacteriuria.

3.16.2.3.2 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 [540]. The meta-analysis found that post-operative pyuria and bacteriuria rates were significantly lower in patients who received pre-operative antibiotic prophylaxis pyuria (OR: 0.42, 95% CI 0.25–0.69 and OR: 0.25, 95% CI 0.11–0.58, respectively). Five studies assessed post-operative febrile UTI (fUTI) and found no difference in the rate of fUTIs between 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 post-operative fever in the pre-operative antibiotic prophylaxis group (OR: 1.75, 95% CI 1.22–2.50; $p=0.002$) was reported. A subgroup analysis on the type of pre-operative antibiotic prophylaxis found no difference between a single dose of oral vs. intravenous antibiotics [540].

A RCT comparing different ciprofloxacin-based antibiotic prophylaxis regimens on the incidence of SIRS after URS found there was no difference in the incidences of SIRS between the regimens including the zero-dose regime [541]. However, there was a greater risk of SIRS in patients who did not receive antibiotic prophylaxis when the stone size was $> 200 \text{ mm}^2$ [541]. 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 [542].

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.

3.16.2.3.3 Percutaneous nephrolithotomy (PNL)

The largest systematic review and meta-analysis performed, latest search date April 2019, included 1,549 patients in thirteen comparative studies on antibiotic prophylaxis strategies for PNL [543]. Compared with a single dose before surgery pre-operative antibiotic prophylaxis significantly reduced post-operative sepsis and fever (OR 0.31, 95%CI 0.20-0.50 and OR 0.26, 95%CI 0.14-0.48, respectively) [543]. Similarly, the rate of positive pelvic urine and positive stones culture were reduced when pre-operative prophylaxis was given. There was no difference in sepsis rates between patients receiving or not receiving post-operative prophylaxis; however, patients who received post-operative antibiotic prophylaxis had more fever [543].

Four RCTs with overall low risk of bias comparing different antibiotic regimes in PNL were identified [544–547]. Seyrek *et al.*, compared the rate of SIRS following PNL in 191 patients receiving either a combination of sulbactam/ampicillin or cefuroxime. There was no difference in SIRS or urosepsis rates [544]. 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 3 (1) days in 73 participants undergoing PNL. They found no difference in rate of infectious complications between the two antibiotic regimens [545]. Taken *et al.*, compared the administration of 1g ceftriaxone and 1g cefazoline both administered 30 minutes before surgery and continued till nephrostomy removal. They found no difference in terms of SRIS or sepsis between groups [547]. Omar *et al.*, compared ciprofloxacin 200 mg IV vs. 2 mg cefotaxime 30 minutes before and 12hours after surgery and found a higher rate of fever in the cefotaxime group [546]. However, these results remain limited by the high risk of bias and the lack of data regarding post-operative infection. These studies give moderate evidence that a single dose of a suitable agent was adequate for prophylaxis against clinical infection after PNL.

3.16.2.4 Transurethral resection of the prostate

A systematic review of 39 RCTs with search date up to 2009 was identified [548]. The update 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 men addressed the risk of septic episodes, 17 trials reported procedure related fever and 39 investigated bacteriuria. 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 a 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.

3.16.2.5 *Transurethral resection of the bladder*

One systematic review which included seven trials with a total of 1,725 participants was identified [549]. Antimicrobial prophylaxis showed no significant effect on post-operative UTIs [OR (95% CI) 1.55 (0.73 - 3.31)] and asymptomatic bacteriuria [OR (95% CI) 0.43 (0.18 - 1.04)] [549]. The review did not attempt sub-group analysis according to presence of risk factors for post-operative infection such as tumour size. Risk factors for development of post-operative UTIs were evaluated only by three of the included studies and most of the parameters were analysed by no more than one study.

A RCT (n=100) comparing oral fosfomycin 3g (the night before surgery) vs. intravenous ceftazidime 2g (30 min pre- and 24 hrs post-surgery) on post-operative UTIs found that a single oral administration of fosfomycin was non-inferior to intravenous administration of ceftazidime in the prevention of post-TURB UTI, even in patients considered at higher risk [550].

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

3.16.2.6 *Midurethral slings*

One systematic review and meta-analysis identified one study assessing the role of pre-operative antibiotics for midurethral sling surgery alone [551]. The study was halted due to low rate of infectious outcomes seen at the first scheduled interim analysis. The study enrolled 29 women 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 [551].

3.16.2.7 *Renal tumour ablation*

One systematic review publication date 2018 included 6,952 patients across 51 studies [552]. 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 its association to infectious complications due to lack of reporting.

3.16.2.8 *Prostate biopsy*

3.16.2.8.1 *Transperineal prostate biopsy*

A total of eight randomised studies including 1,596 patients compared the impact of biopsy route on infectious complications. Infectious complications were significantly higher following transrectal biopsy (48 events among 789 men) compared to transperineal biopsy (22 events among 807 men), [RR (95% CIs) 2.48 (1.47 to 4.2) [553, 554]. 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 [555]. Finally, a population-based study from the UK (n=73,630) showed lower re-admission rates for sepsis in patients who had transperineal versus transrectal biopsies (1.0% vs, 1.4%, respectively) [556]. The available evidence demonstrates that the transrectal approach should be abandoned in favour of the transperineal approach despite any possible logistical challenges.

A systematic review and meta-analysis of eight non-RCTs reported no significant differences between patients receiving or not receiving antibiotic prophylaxis in terms of post-biopsy infection (0.11% vs. 0.31%) and sepsis (0.13% vs. 0.09%), for the transperineal approach [557]. 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) [558]. In addition, two recently published RCTs have reported comparably low post-biopsy infection rates for transperineal biopsy regardless of whether antibiotic prophylaxis was administered or not [559, 560].

There is a growing body of evidence to suggest that antibiotic prophylaxis may not be required for transperineal biopsy; however, the Panel have chosen to wait until a number of ongoing RCTs report their study findings before making a recommendation on this.

3.16.2.8.2 *Transrectal prostate biopsy*

An updated meta-analysis of eleven RCTs including 2,237 men showed that 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% CIs) 0.47 (0.36 to 0.61) [553, 561-563]. Single RCTs showed no evidence of benefit for perineal skin disinfection [564], but reported an advantage for rectal povidone-iodine preparation before biopsy compared to after biopsy [565].

A meta-analysis of four RCTs including 671 men evaluated the use of rectal preparation by enema before transrectal biopsy. No significant advantage was found regarding infectious complications [RR (95% CIs) 0.96 (0.64 to 1.54)] [553].

An updated meta-analysis of 29 RCTs with 4,127 patients found no evidence that use of peri-prostatic injection of local anaesthesia resulted in more infectious complications than no injection [RR (95% CIs) 1.08 (0.80 to 1.49)] [553, 554, 566, 567]. 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 to 1.24)] [553, 568]. Additional meta-analyses found no difference in infectious complications regarding needle guide type (disposable vs. reusable), needle type (coaxial vs. non-coaxial), needle size (large vs. small), and number of injections for peri-prostatic nerve block (standard vs. extended) [553].

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% CIs) 0.56 (0.40 to 0.77)] [569].

Fluoroquinolones have been traditionally used for antibiotic prophylaxis in this setting; however, overuse and misuse of fluoroquinolones has 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 peri-operative antibiotic prophylaxis including prostate biopsy [138].

A systematic review and meta-analysis on antibiotic prophylaxis for the prevention of infectious complications following prostate biopsy concluded that in countries where fluoroquinolones are allowed as antibiotic prophylaxis, a minimum of a full one-day administration is recommended [569]. An updated meta-analysis of eight RCTs with 2,939 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% CIs) 0.54 (0.40 to 0.72)] [569]. In addition, an updated 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 [RR (95% CIs) 0.44 (0.32 to 0.59)] [569, 570]. In countries where use of fluoroquinolones are suspended cephalosporins or aminoglycosides can be used as individual agents with comparable infectious complications based on meta-analysis of two RCTs [569]. An updated meta-analysis of four RCTs compared fosfomycin trometamol to fluoroquinolones [RR (95% CIs) 0.62 (0.37 to 1.06)] [569, 571]. 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 [571]. Therefore, routine general use should be critically assessed due to the relevant infectious complications also reported in non-randomised studies [572]. Of note 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. 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 1 for prostate biopsy workflow to reduce infectious complications.

3.16.3 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 vs. placebo in patients following filling and voiding cystometry.	1b
A meta-analysis of five trials of moderate quality showed a benefit for 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
Two meta-analyses found no benefit for antibiotic prophylaxis following ESWL in terms of reducing the rate of post-procedural fever and bacteriuria or trial-defined infection in patients without bacteriuria.	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 eight studies including 1,596 patients showed significantly reduced infectious complications in patients undergoing transperineal biopsy as compared to transrectal biopsy.	1a
A meta-analysis of eight non-RCTS reported comparable rates of post-biopsy infections in patients undergoing transperineal biopsy irrespective if antibiotic prophylaxis was given or not.	1a
A meta-analysis of eleven RCTs including 2,237 men showed that 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
A meta-analysis on eleven studies with 1,753 patients showed significantly reduced infections after transrectal biopsy when using antimicrobial prophylaxis as compared to placebo/control.	1a

Recommendations	Strength rating
Do not use antibiotic prophylaxis to reduce the rate of symptomatic urinary infection following: <ul style="list-style-type: none"> • urodynamics; • cystoscopy; • extracorporeal shockwave lithotripsy. 	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.	Strong
Use routine surgical disinfection of the perineal skin for transperineal biopsy.	Strong
Use rectal cleansing with povidone-iodine in men prior to transrectal prostate biopsy.	Strong
Do not use fluoroquinolones for prostate biopsy in line with the European Commission final decision on EMEA/H/A-31/1452.	Strong
Use either target prophylaxis based on rectal swab or stool culture; augmented prophylaxis (two or more different classes of antibiotics); or alternative antibiotics (e.g. fosfomycin trometamol*, cephalosporin, aminoglycoside) for antibiotic prophylaxis for transrectal biopsy.	Weak

**Of note 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.*

Table 13: Suggested regimens for antimicrobial prophylaxis prior to urological procedures

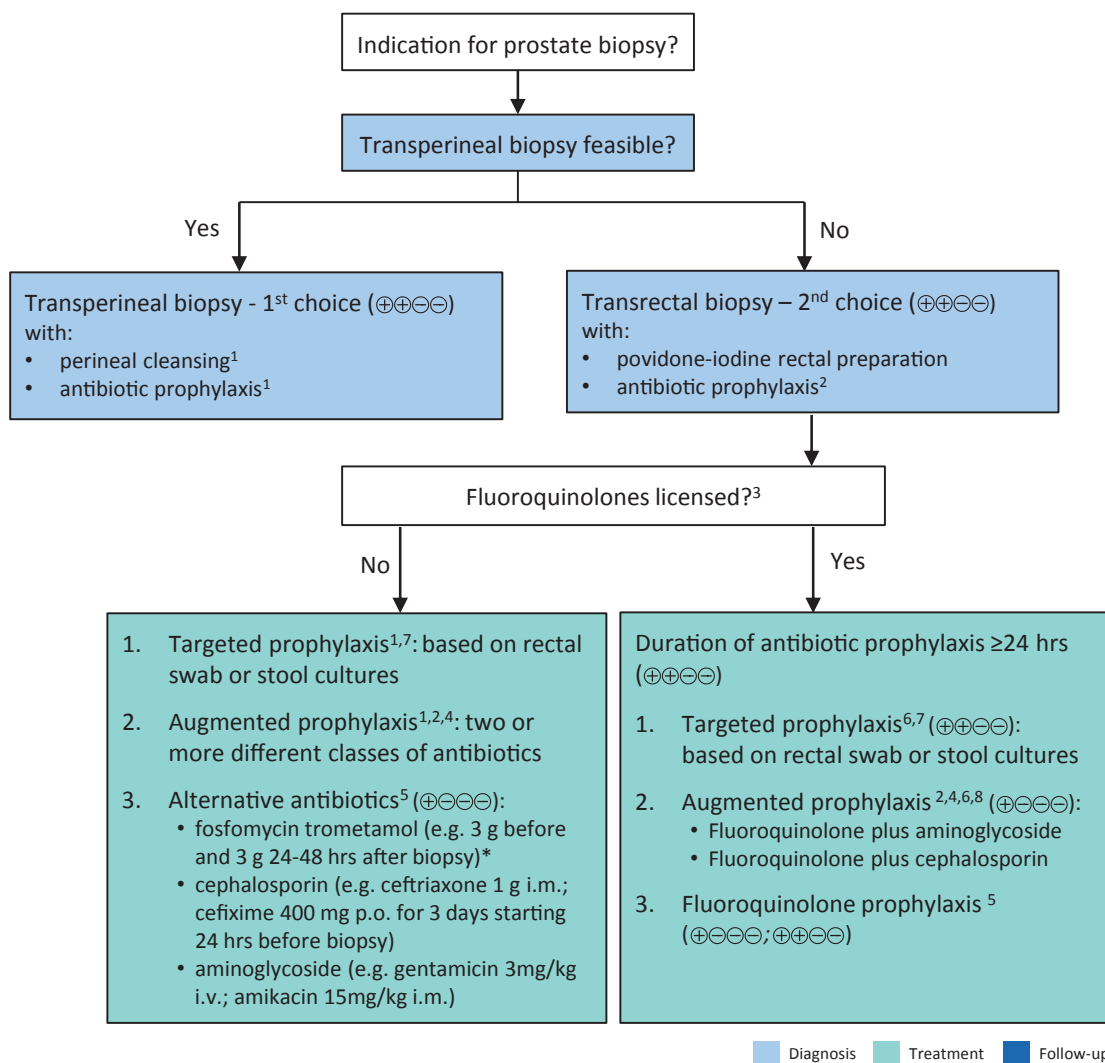
As stated in section 3.14.1.4 the panel has decided not to make recommendations for specific agents for particular procedures, those listed below represent possible choices only. Urologists should choose a specific antimicrobial based on their knowledge of local pathogen prevalence for each type of procedure, their antibiotic susceptibility profiles and virulence.

Procedure	Prophylaxis recommended	Antimicrobial
Urodynamics	No	N/A
Cystoscopy	No	
Extracorporeal shockwave lithotripsy	No	
Ureteroscopy	Yes	Trimethoprim Trimethoprim-sulphamethoxazole Cephalosporin group 2 or 3 Aminopenicillin <u>plus</u> a beta-lactamase inhibitor
Percutaneous nephrolithotomy	Yes (single dose)	
Transurethral resection of the prostate	Yes	
Transurethral resection of the bladder	Yes, in patients who have a high risk of suffering post-operative sepsis.	
Transrectal prostate biopsy	Yes	<ol style="list-style-type: none"> 1. Targeted prophylaxis - based on rectal swab or stool culture. 2. Augmented prophylaxis - two or more different classes of antibiotics*. 2. Alternative antibiotics <ul style="list-style-type: none"> • fosfomycin trometamol** (e.g. 3 g before and 3 g 24-48 hrs after biopsy) • cephalosporin (e.g. ceftriaxone 1 g i.m.; cefixime 400 mg p.o. for 3 days starting 24 hrs before biopsy) • aminoglycoside (e.g. gentamicin 3mg/kg i.v.; amikacin 15mg/kg i.m.)

* Note option 2 is against antibiotic stewardship programmes

** Of note 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).
9. Significantly inferior to targeted and augmented prophylaxis.

GRADE Working Group grades 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., [573] with permission from Elsevier.

* Of note 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, edition presented at the annual EAU Congress Milan 2023. ISBN 978-94-92671-19-6.
<https://pubmed.ncbi.nlm.nih.gov/25477258/>
2. Blok, B., *et al.* EAU Guidelines on Neuro-urology. In: EAU Guidelines, edition presented at the annual EAU Congress Milan 2023. ISBN 978-94-92671-19-6.
<https://uroweb.org/guideline/neuro-urology/>
1. Stein, R., *et al.* Urinary tract infections in children: EAU/ESPU guidelines. *Eur Urol*, 2015. 67: 546.
<https://pubmed.ncbi.nlm.nih.gov/25477258>
2. Blok, B., *et al.* EAU Guidelines on Neuro-urology. In: EAU Guidelines, edition presented at the annual EAU Congress Amsterdam 2022. ISBN 978-94-92671-16-5.
<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://pubmed.ncbi.nlm.nih.gov/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://pubmed.ncbi.nlm.nih.gov/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://pubmed.ncbi.nlm.nih.gov/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, F.a.D.A., Center for Drug Evaluation and Research (CDER). 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, F.a.D.A., Center for Drug Evaluation and Research (CDER). Complicated Urinary Tract Infections: Developing Drugs for Treatment Guidance for Industry 2018.
<https://www.fda.gov/regulatory-information/search-fda-guidance-documents/complicated-urinary-tract-infections-developing-drugs-treatment>
10. Johansen, T.E., *et al.* Critical review of current definitions of urinary tract infections and proposal of an EAU/ESIU classification system. *Int J Antimicrob Agents*, 2011. 38 Suppl: 64.
<https://pubmed.ncbi.nlm.nih.gov/22018988>
11. Singer, M., *et al.* The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA*, 2016. 315: 801.
<https://pubmed.ncbi.nlm.nih.gov/26903338>
12. 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://pubmed.ncbi.nlm.nih.gov/24405683>
13. WHO. Antimicrobial resistance: global report on surveillance 2014. 2014.
<https://www.who.int/publications/i/item/9789241564748>
14. Hulscher, M.E., *et al.* Antibiotic prescribing in hospitals: a social and behavioural scientific approach. *Lancet Infect Dis*, 2010. 10: 167.
<https://pubmed.ncbi.nlm.nih.gov/20185095>
15. 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://pubmed.ncbi.nlm.nih.gov/27866945>
16. 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://pubmed.ncbi.nlm.nih.gov/17173212>
17. Davey, P., *et al.* Interventions to improve antibiotic prescribing practices for hospital inpatients. *Cochrane Database Syst Rev*, 2017. 2: CD003543.
<https://pubmed.ncbi.nlm.nih.gov/28178770>

18. Cefai, C., *et al.* Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use. NICE Guidelines, 2015.
<https://www.nice.org.uk/guidance/ng15>
19. 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://pubmed.ncbi.nlm.nih.gov/26947617>
20. 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://pubmed.ncbi.nlm.nih.gov/18230045>
21. 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://pubmed.ncbi.nlm.nih.gov/24158412>
22. Lutay, N., *et al.* Bacterial control of host gene expression through RNA polymerase II. *J Clin Invest*, 2013. 123: 2366.
<https://pubmed.ncbi.nlm.nih.gov/23728172>
23. Hansson, S., *et al.* Untreated asymptomatic bacteriuria in girls: II—Effect of phenoxymethylpenicillin and erythromycin given for intercurrent infections. *BMJ*, 1989. 298: 856.
<https://pubmed.ncbi.nlm.nih.gov/2497823>
24. 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://pubmed.ncbi.nlm.nih.gov/22677710>
25. 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://pubmed.ncbi.nlm.nih.gov/15714408>
26. Kass, E.H. Asymptomatic infections of the urinary tract. *Trans Assoc Am Physicians*, 1956. 69: 56.
<https://pubmed.ncbi.nlm.nih.gov/13380946>
27. 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://pubmed.ncbi.nlm.nih.gov/383746>
28. 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://pubmed.ncbi.nlm.nih.gov/6815281>
29. Kunin CM. Urinary tract infections: detection, prevention and management. 5th ed. . Baltimore: Williams and Wilkins., 1997.
30. 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://pubmed.ncbi.nlm.nih.gov/28754533>
31. Tencer, J. Asymptomatic bacteriuria—a long-term study. *Scand J Urol Nephrol*, 1988. 22: 31.
<https://pubmed.ncbi.nlm.nih.gov/3387908>
32. Asscher, A.W., *et al.* The clinical significance of asymptomatic bacteriuria in the nonpregnant woman. *J Infect Dis*, 1969. 120: 17.
<https://pubmed.ncbi.nlm.nih.gov/5803281>
33. 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://pubmed.ncbi.nlm.nih.gov/4937729>
34. Elder, H.A., *et al.* Use of sulfasymazine in the treatment of bacteriuria of pregnancy. *Antimicrob Agents Chemother (Bethesda)*, 1966. 6: 142.
<https://pubmed.ncbi.nlm.nih.gov/4862162>
35. Gold, E.M., *et al.* Asymptomatic bacteriuria during pregnancy. *Obstet Gynecol*, 1966. 27: 206.
<https://pubmed.ncbi.nlm.nih.gov/5325600>
36. Kass, E.H. Pyelonephritis and bacteriuria. A major problem in preventive medicine. *Ann Intern Med*, 1962. 56: 46.
<https://pubmed.ncbi.nlm.nih.gov/14454174>
37. Kincaid-Smith, P., *et al.* Bacteriuria in Pregnancy. *Lancet*, 1965. 1: 395.
<https://pubmed.ncbi.nlm.nih.gov/14238090>
38. Little, P.J. The incidence of urinary infection in 5000 pregnant women. *Lancet*, 1966. 2: 925.
<https://pubmed.ncbi.nlm.nih.gov/4162367>
39. Mulla, N. Bacteriuria in pregnancy. *Obstet Gynecol*, 1960. 16: 89.
<https://pubmed.ncbi.nlm.nih.gov/14425118>
40. Pathak, U.N., *et al.* Bacteriuria of pregnancy: results of treatment. *J Infect Dis*, 1969. 120: 91.
<https://pubmed.ncbi.nlm.nih.gov/5816817>

41. Robertson, J.G., *et al.* The management and complications of asymptomatic bacteriuria in pregnancy. Report of a study on 8,275 patients. *J Obstet Gynaecol Br Commonw*, 1968. 75: 59.
<https://pubmed.ncbi.nlm.nih.gov/5635245>
42. Thomsen, A.C., *et al.* Antibiotic elimination of group-B streptococci in urine in prevention of preterm labour. *Lancet*, 1987. 1: 591.
<https://pubmed.ncbi.nlm.nih.gov/2881132>
43. Williams, G.L., *et al.* Urinary concentrating ability in women with asymptomatic bacteriuria in pregnancy. *Br Med J*, 1969. 3: 212.
<https://pubmed.ncbi.nlm.nih.gov/5792611>
44. Wren, B.G. Subclinical renal infection and prematurity. *Med J Aust*, 1969. 2: 596.
<https://pubmed.ncbi.nlm.nih.gov/5388374>
45. 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://pubmed.ncbi.nlm.nih.gov/26255208>
46. 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://pubmed.ncbi.nlm.nih.gov/31550037>
47. Smail, F.M., *et al.* Antibiotics for asymptomatic bacteriuria in pregnancy. *Cochrane Database Syst Rev*, 2019. 2019: CD000490.
<https://pubmed.ncbi.nlm.nih.gov/31765489>
48. Wingert, A., *et al.* Asymptomatic bacteriuria in pregnancy: systematic reviews of screening and treatment effectiveness and patient preferences. *BMJ Open*, 2019. 9: e021347.
<https://pubmed.ncbi.nlm.nih.gov/30872538>
49. Christopher, L.J., *et al.* A trial of hippuramine in the treatment of bacteriuria of pregnancy. *Ir J Med Sci*, 1969. 8: 331.
<https://pubmed.ncbi.nlm.nih.gov/5806178>
50. Reeves, D.S. Laboratory and clinical studies with sulfametyopyrazine as a treatment for bacteriuria in pregnancy. *J Antimicrob Chemother*, 1975. 1: 171.
<https://pubmed.ncbi.nlm.nih.gov/1100589>
51. Whalley, P.J., *et al.* Short-term versus continuous antimicrobial therapy for asymptomatic bacteriuria in pregnancy. *Obstet Gynecol*, 1977. 49: 262.
<https://pubmed.ncbi.nlm.nih.gov/320525>
52. Bint, A., *et al.* A comparative trial of pivmecillinam and ampicillin in bacteriuria of pregnancy. *Infection*, 1979. 7: 290.
<https://pubmed.ncbi.nlm.nih.gov/232697>
53. Harris, R.E., *et al.* Single-dose antimicrobial therapy for asymptomatic bacteriuria during pregnancy. *Obstet Gynecol*, 1982. 59: 546.
<https://pubmed.ncbi.nlm.nih.gov/7070725>
54. 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://pubmed.ncbi.nlm.nih.gov/6606421>
55. Masterton, R.G., *et al.* Single-dose amoxicillin in the treatment of bacteriuria in pregnancy and the puerperium—a controlled clinical trial. *Br J Obstet Gynaecol*, 1985. 92: 498.
<https://pubmed.ncbi.nlm.nih.gov/3888250>
56. 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://pubmed.ncbi.nlm.nih.gov/4004191>
57. Campbell-Brown, M., *et al.* Is screening for bacteriuria in pregnancy worth while? *Br Med J (Clin Res Ed)*, 1987. 294: 1579.
<https://pubmed.ncbi.nlm.nih.gov/3113538>
58. Pregazzi, R., *et al.* [Single-dose antibiotic therapy of asymptomatic bacteriuria in pregnancy. Results and complications]. *Minerva Ginecol*, 1987. 39: 289.
<https://pubmed.ncbi.nlm.nih.gov/3601207>
59. 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://pubmed.ncbi.nlm.nih.gov/2659442>
60. 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://pubmed.ncbi.nlm.nih.gov/2680315>

61. Thousin, 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://pubmed.ncbi.nlm.nih.gov/2286469>
62. Bayrak, O., *et al.* Is single-dose fosfomycin trometamol a good alternative for asymptomatic bacteriuria in the second trimester of pregnancy? *Int Urogynecol J Pelvic Floor Dysfunct*, 2007. 18: 525.
<https://pubmed.ncbi.nlm.nih.gov/16941068>
63. 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://pubmed.ncbi.nlm.nih.gov/19768649>
64. 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://pubmed.ncbi.nlm.nih.gov/19155904>
65. Widmer, M., *et al.* Duration of treatment for asymptomatic bacteriuria during pregnancy. *Cochrane Database Syst Rev*, 2015. 2015: CD000491.
<https://pubmed.ncbi.nlm.nih.gov/26560337>
66. 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://pubmed.ncbi.nlm.nih.gov/32417205>
67. Zhanel, G.G., *et al.* Asymptomatic bacteriuria in patients with diabetes mellitus. *Rev Infect Dis*, 1991. 13: 150.
<https://pubmed.ncbi.nlm.nih.gov/2017615>
68. Harding, G.K., *et al.* Antimicrobial treatment in diabetic women with asymptomatic bacteriuria. *N Engl J Med*, 2002. 347: 1576.
<https://pubmed.ncbi.nlm.nih.gov/12432044>
69. Mody, L., *et al.* Urinary tract infections in older women: a clinical review. *JAMA*, 2014. 311: 844.
<https://pubmed.ncbi.nlm.nih.gov/24570248>
70. Boscia, J.A., *et al.* Therapy vs no therapy for bacteriuria in elderly ambulatory nonhospitalized women. *JAMA*, 1987. 257: 1067.
<https://pubmed.ncbi.nlm.nih.gov/3806896>
71. 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://pubmed.ncbi.nlm.nih.gov/7818631>
72. 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://pubmed.ncbi.nlm.nih.gov/8600199>
73. 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://pubmed.ncbi.nlm.nih.gov/3300325>
74. Nicolle, L.E. Asymptomatic bacteriuria in the elderly. *Infect Dis Clin North Am*, 1997. 11: 647.
<https://pubmed.ncbi.nlm.nih.gov/9378928>
75. 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://pubmed.ncbi.nlm.nih.gov/21119801>
76. Trautner, B.W. Asymptomatic bacteriuria: when the treatment is worse than the disease. *Nat Rev Urol*, 2011. 9: 85.
<https://pubmed.ncbi.nlm.nih.gov/22143416>
77. Nicolle, L.E., *et al.* Bacteriuria in elderly institutionalized men. *N Engl J Med*, 1983. 309: 1420.
<https://pubmed.ncbi.nlm.nih.gov/6633618>
78. 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://pubmed.ncbi.nlm.nih.gov/15374159>
79. Renneberg, J., *et al.* Single-day treatment with trimethoprim for asymptomatic bacteriuria in the elderly patient. *J Urol*, 1984. 132: 934.
<https://pubmed.ncbi.nlm.nih.gov/6387184>
80. 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://pubmed.ncbi.nlm.nih.gov/7717597>
81. 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://pubmed.ncbi.nlm.nih.gov/35940886>

82. Moradi, M., *et al.* Effect of antibiotic therapy on asymptomatic bacteriuria in kidney transplant recipients. *Urol J*, 2005. 2: 32.
<https://pubmed.ncbi.nlm.nih.gov/17629893>
83. El Amari, E.B., *et al.* Outcome of treated and untreated asymptomatic bacteriuria in renal transplant recipients. *Nephrol Dial Transplant*, 2011. 26: 4109.
<https://pubmed.ncbi.nlm.nih.gov/21592976>
84. 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://pubmed.ncbi.nlm.nih.gov/22918514>
85. Origuén, 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://pubmed.ncbi.nlm.nih.gov/27088545>
86. 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://pubmed.ncbi.nlm.nih.gov/35980169>
87. 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://pubmed.ncbi.nlm.nih.gov/31214630>
88. Arencibia, N., *et al.* Short-Term Outcome of Untreated Versus Treated Asymptomatic Bacteriuria in Renal Transplant Patients. *Transplant Proc*, 2016. 48: 2941.
<https://pubmed.ncbi.nlm.nih.gov/27932112>
89. Coussement, J., *et al.* Antibiotics for asymptomatic bacteriuria in kidney transplant recipients. *Cochrane Database Syst Rev*, 2018. 2: CD011357.
<https://pubmed.ncbi.nlm.nih.gov/29390169>
90. 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://pubmed.ncbi.nlm.nih.gov/31782870>
91. Nicolle, L.E. Urinary tract infections in patients with spinal injuries. *Curr Infect Dis Rep*, 2014. 16: 390.
<https://pubmed.ncbi.nlm.nih.gov/24445675>
92. Wullt, B., *et al.* Bladder, bowel and bugs--bacteriuria in patients with intestinal urinary diversion. *World J Urol*, 2004. 22: 186.
<https://pubmed.ncbi.nlm.nih.gov/15309491>
93. 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://pubmed.ncbi.nlm.nih.gov/31560122>
94. 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://pubmed.ncbi.nlm.nih.gov/16231269>
95. 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://pubmed.ncbi.nlm.nih.gov/20483149>
96. Bonkat, G., *et al.* Microbial biofilm formation and catheter-associated bacteriuria in patients with suprapubic catheterisation. *World J Urol*, 2013. 31: 565.
<https://pubmed.ncbi.nlm.nih.gov/22926265>
97. 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://pubmed.ncbi.nlm.nih.gov/18006279>
98. Cooper, F.P., *et al.* Policies for replacing long-term indwelling urinary catheters in adults. *Cochrane Database Syst Rev*, 2016. 7: CD011115.
<https://pubmed.ncbi.nlm.nih.gov/27457774>
99. Dasgupta, R., *et al.* Preoperative antibiotics before endourologic surgery: current recommendations. *J Endourol*, 2009. 23: 1567.
<https://pubmed.ncbi.nlm.nih.gov/19785548>
100. 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://pubmed.ncbi.nlm.nih.gov/10619727>
101. Grabe, M., *et al.* The effect of a short antibiotic course in transurethral prostatic resection. *Scand J Urol Nephrol*, 1984. 18: 37.
<https://pubmed.ncbi.nlm.nih.gov/6202000>

102. 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://pubmed.ncbi.nlm.nih.gov/3569248>
103. Cafferkey, M.T., *et al.* Antibiotics for the prevention of septicaemia in urology. *J Antimicrob Chemother*, 1982. 9: 471.
<https://pubmed.ncbi.nlm.nih.gov/7107549>
104. 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://pubmed.ncbi.nlm.nih.gov/6725613>
105. 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://pubmed.ncbi.nlm.nih.gov/24621035>
106. 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://pubmed.ncbi.nlm.nih.gov/23430723>
107. Sousa, R., *et al.* Is asymptomatic bacteriuria a risk factor for prosthetic joint infection? *Clin Infect Dis*, 2014. 59: 41.
<https://pubmed.ncbi.nlm.nih.gov/24723280>
108. 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://pubmed.ncbi.nlm.nih.gov/33864153>
109. 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://pubmed.ncbi.nlm.nih.gov/30688601>
110. 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://pubmed.ncbi.nlm.nih.gov/33021755>
111. 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://pubmed.ncbi.nlm.nih.gov/30956050>
112. 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://pubmed.ncbi.nlm.nih.gov/29368046>
113. 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://pubmed.ncbi.nlm.nih.gov/30652758>
114. Foxman, B. Epidemiology of urinary tract infections: incidence, morbidity, and economic costs. *Dis Mon*, 2003. 49: 53.
<https://pubmed.ncbi.nlm.nih.gov/12601337>
115. Wagenlehner, F.M., *et al.* Uncomplicated urinary tract infections. *Dtsch Arztebl Int*, 2011. 108: 415.
<https://pubmed.ncbi.nlm.nih.gov/21776311>
116. Stamm, W.E., *et al.* Management of urinary tract infections in adults. *N Engl J Med*, 1993. 329: 1328.
<https://pubmed.ncbi.nlm.nih.gov/8413414>
117. 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://pubmed.ncbi.nlm.nih.gov/11438412>
118. 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://pubmed.ncbi.nlm.nih.gov/29910137>
119. Bent, S., *et al.* Does this woman have an acute uncomplicated urinary tract infection? *JAMA*, 2002. 287: 2701.
<https://pubmed.ncbi.nlm.nih.gov/12020306>
120. 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://pubmed.ncbi.nlm.nih.gov/3256648>
121. Lifshitz, E., *et al.* Outpatient urine culture: does collection technique matter? *Arch Intern Med*, 2000. 160: 2537.
<https://pubmed.ncbi.nlm.nih.gov/10979067>
122. Fihn, S.D. Clinical practice. Acute uncomplicated urinary tract infection in women. *N Engl J Med*, 2003. 349: 259.
<https://pubmed.ncbi.nlm.nih.gov/12867610>
123. 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://pubmed.ncbi.nlm.nih.gov/12848468>

124. 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://pubmed.ncbi.nlm.nih.gov/19195714>
125. Gagyor, 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>
126. 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>
127. 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>
128. 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://pubmed.ncbi.nlm.nih.gov/30231252>
129. 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>
130. Gupta, K., *et al.* Short-course nitrofurantoin for the treatment of acute uncomplicated cystitis in women. *Arch Intern Med*, 2007. 167: 2207.
<https://pubmed.ncbi.nlm.nih.gov/17998493>
131. 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>
132. Nicolle, L.E. Pivmecillinam in the treatment of urinary tract infections. *J Antimicrob Chemother*, 2000. 46 Suppl 1: 35.
<https://pubmed.ncbi.nlm.nih.gov/11051622>
133. Huttner, A., *et al.* Nitrofurantoin revisited: a systematic review and meta-analysis of controlled trials. *J Antimicrob Chemother*, 2015. 70: 2456.
<https://pubmed.ncbi.nlm.nih.gov/26066581>
134. 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://pubmed.ncbi.nlm.nih.gov/12135847>
135. 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://pubmed.ncbi.nlm.nih.gov/10589881>
136. Hooton, T.M., *et al.* Cefpodoxime vs ciprofloxacin for short-course treatment of acute uncomplicated cystitis: a randomized trial. *JAMA*, 2012. 307: 583.
<https://pubmed.ncbi.nlm.nih.gov/22318279>
137. 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://pubmed.ncbi.nlm.nih.gov/15728165>
138. 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/documents/referral/quinolone-fluoroquinolone-article-31-referral-disabling-potentially-permanent-side-effects-lead_en.pdf
139. Vazquez, J.C., *et al.* Treatments for symptomatic urinary tract infections during pregnancy. *Cochrane Database Syst Rev*, 2000: CD002256.
<https://pubmed.ncbi.nlm.nih.gov/10908537>
140. Wagenlehner, F.M., *et al.* Antimicrobials in urogenital infections. *Int J Antimicrob Agents*, 2011. 38 Suppl: 3.
<https://pubmed.ncbi.nlm.nih.gov/22019184>
141. 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://pubmed.ncbi.nlm.nih.gov/23660771>
142. Hooton, T.M. Recurrent urinary tract infection in women. *Int J Antimicrob Agents*, 2001. 17: 259.
<https://pubmed.ncbi.nlm.nih.gov/11295405>
143. Naber, K.G., *et al.* Psychosocial burden of recurrent uncomplicated urinary tract infections. *GMS Infect Dis*, 2022. 10: Doc01.
<https://pubmed.ncbi.nlm.nih.gov/35463815>

144. 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://pubmed.ncbi.nlm.nih.gov/11377307>
145. 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.
146. 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://pubmed.ncbi.nlm.nih.gov/35135727>
147. Adatto, K., *et al.* Behavioral factors and urinary tract infection. *JAMA*, 1979. 241: 2525.
<https://pubmed.ncbi.nlm.nih.gov/439337>
148. 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://pubmed.ncbi.nlm.nih.gov/3984360>
149. 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://pubmed.ncbi.nlm.nih.gov/30285042>
150. 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://pubmed.ncbi.nlm.nih.gov/32564121>
151. 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://pubmed.ncbi.nlm.nih.gov/23867306>
152. 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. *Journal of Clinical Gerontology and Geriatrics*, 2010. 1: 31.
<https://www.sciencedirect.com/science/article/pii/S2210833510000298?via%3Dihub>
153. 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://pubmed.ncbi.nlm.nih.gov/26825411>
154. 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://pubmed.ncbi.nlm.nih.gov/15661421>
155. Aziminia, N., *et al.* Vaccines for the prevention of recurrent urinary tract infections: a systematic review. *BJU Int*, 2019. 123: 753.
<https://pubmed.ncbi.nlm.nih.gov/30378242>
156. Prattley, S., *et al.* Role of Vaccines for Recurrent Urinary Tract Infections: A Systematic Review. *Eur Urol Focus*, 2020. 6: 593.
<https://pubmed.ncbi.nlm.nih.gov/31806578>
157. Naber, K.G., *et al.* Immunoactive prophylaxis of recurrent urinary tract infections: a meta-analysis. *Int J Antimicrob Agents*, 2009. 33: 111.
<https://pubmed.ncbi.nlm.nih.gov/18963856>
158. Nickel, J.C., *et al.* Could sublingual vaccination be a viable option for the prevention of recurrent urinary tract infection in Canada? A systematic review of the current literature and plans for the future. *Can Urol Assoc J*, 2020. 14: 281.
<https://pubmed.ncbi.nlm.nih.gov/33626320>
159. Lorenzo-Gómez, M.-F., *et al.* Sublingual MV140 for Prevention of Recurrent Urinary Tract Infections. *NEJM Evidence*, 2022. 1: EVIDoa2100018.
<https://evidence.nejm.org/doi/full/10.1056/EVIDoa2100018>
160. Nestler, S., *et al.* Efficacy of vaccination with Strovac for recurrent urinary tract infections in women: a comparative single-centre study. *Int Urol Nephrol*, 2021. 53: 2267.
<https://pubmed.ncbi.nlm.nih.gov/34499326>
161. Kranz, J., *et al.* Current Evidence on Nonantibiotic Prevention of Recurrent Urinary Tract Infections. *Eur Urol Focus*, 2019. 5: 17.
<https://pubmed.ncbi.nlm.nih.gov/30292420>
162. 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://pubmed.ncbi.nlm.nih.gov/19567343>
163. Canales, J., *et al.* Are probiotics effective in preventing urinary tract infection? *Medwave*, 2018. 18: e7186.
<https://pubmed.ncbi.nlm.nih.gov/29624569>

164. 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://pubmed.ncbi.nlm.nih.gov/16827601>
165. Grin, P.M., *et al.* Lactobacillus for preventing recurrent urinary tract infections in women: meta-analysis. *Can J Urol*, 2013. 20: 6607.
<https://pubmed.ncbi.nlm.nih.gov/23433130>
166. 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://pubmed.ncbi.nlm.nih.gov/27218592>
167. Ng, Q.X., *et al.* Use of Lactobacillus spp. to prevent recurrent urinary tract infections in females. *Med Hypotheses*, 2018. 114: 49.
<https://pubmed.ncbi.nlm.nih.gov/29602464>
168. Akgul, T., *et al.* The role of probiotics in women with recurrent urinary tract infections. *Turk J Urol*, 2018. 44: 377.
<https://pubmed.ncbi.nlm.nih.gov/30487041>
169. Andreu, A. Lactobacillus as a probiotic for preventing urogenital infections. *Reviews in Medical Microbiology*, 2004. 15: 1.
https://journals.lww.com/revmedmicrobiol/Abstract/2004/01000/Lactobacillus_as_a_probiotic_for_preventing.1.aspx
170. Barrons, R., *et al.* Use of Lactobacillus probiotics for bacterial genitourinary infections in women: a review. *Clin Ther*, 2008. 30: 453.
<https://pubmed.ncbi.nlm.nih.gov/18405785>
171. Hoesl, C.E., *et al.* The probiotic approach: an alternative treatment option in urology. *Eur Urol*, 2005. 47: 288.
<https://pubmed.ncbi.nlm.nih.gov/15716188>
172. Ray, K. Infection: Lactobacillus probiotic could prevent recurrent UTI. *Nat Rev Urol*, 2011. 8: 292.
<https://pubmed.ncbi.nlm.nih.gov/21660070>
173. Reid, G., *et al.* Probiotics to prevent urinary tract infections: the rationale and evidence. *World J Urol*, 2006. 24: 28.
<https://pubmed.ncbi.nlm.nih.gov/16389539>
174. 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://pubmed.ncbi.nlm.nih.gov/34671514>
175. Jepson, R.G., *et al.* Cranberries for preventing urinary tract infections. *Cochrane Database Syst Rev*, 2012. 10: CD001321.
<https://pubmed.ncbi.nlm.nih.gov/23076891>
176. 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://pubmed.ncbi.nlm.nih.gov/29046404>
177. 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://pubmed.ncbi.nlm.nih.gov/28288837>
178. 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://pubmed.ncbi.nlm.nih.gov/22777630>
179. Tambunan, M.P., *et al.* Cranberries for women with recurrent urinary tract infection: a meta-analysis. *Medical Journal of Indonesia*, 2019. 28: 268.
<http://mji.ui.ac.id/journal/index.php/mji/article/view/3299/1579>
180. 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://pubmed.ncbi.nlm.nih.gov/34473789>
181. 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://pubmed.ncbi.nlm.nih.gov/27184277>
182. 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://pubmed.ncbi.nlm.nih.gov/33757474>
183. 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://pubmed.ncbi.nlm.nih.gov/32497610>

184. 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://pubmed.ncbi.nlm.nih.gov/32972899>
185. Cooper, T.E., *et al.* D-mannose for preventing and treating urinary tract infections. *Cochrane Database Syst Rev*, 2022. 8: CD013608.
<https://pubmed.ncbi.nlm.nih.gov/36041061>
186. 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://pubmed.ncbi.nlm.nih.gov/21272992>
187. 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://pubmed.ncbi.nlm.nih.gov/22614285>
188. 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://pubmed.ncbi.nlm.nih.gov/29181550>
189. Lee, B.S., *et al.* Methenamine hippurate for preventing urinary tract infections. *Cochrane Database Syst Rev*, 2012. 10: CD003265.
<https://pubmed.ncbi.nlm.nih.gov/23076896>
190. 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://pubmed.ncbi.nlm.nih.gov/34001538>
191. 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://pubmed.ncbi.nlm.nih.gov/35535708>
192. 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://pubmed.ncbi.nlm.nih.gov/35264408>
193. 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://pubmed.ncbi.nlm.nih.gov/31000921>
194. 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://pubmed.ncbi.nlm.nih.gov/28554926>
195. 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://pubmed.ncbi.nlm.nih.gov/27457111>
196. Albert, X., *et al.* Antibiotics for preventing recurrent urinary tract infection in non-pregnant women. *Cochrane Database Syst Rev*, 2004. 2004: CD001209.
<https://pubmed.ncbi.nlm.nih.gov/15266443>
197. 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://pubmed.ncbi.nlm.nih.gov/24065333>
198. Anger, J., *et al.* Recurrent Uncomplicated Urinary Tract Infections in Women: AUA/CUA/SUFU Guideline. *J Urol*, 2019. 202: 282.
<https://pubmed.ncbi.nlm.nih.gov/31042112>
199. 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://pubmed.ncbi.nlm.nih.gov/29539622>
200. Epp, A., *et al.* No. 250-Recurrent Urinary Tract Infection. *J Obstet Gynaecol Can*, 2017. 39: e422.
<https://pubmed.ncbi.nlm.nih.gov/28935065>
201. Lichtenberger, P., *et al.* Antimicrobial prophylaxis in women with recurrent urinary tract infections. *Int J Antimicrob Agents*, 2011. 38 Suppl: 36.
<https://pubmed.ncbi.nlm.nih.gov/22055655>
202. Sen, A. Recurrent cystitis in non-pregnant women. *BMJ Clin Evid*, 2008. 2008.
<https://pubmed.ncbi.nlm.nih.gov/19445741>
203. Chew, L.D., *et al.* Recurrent cystitis in nonpregnant women. *West J Med*, 1999. 170: 274.
<https://pubmed.ncbi.nlm.nih.gov/10379218>

204. 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://pubmed.ncbi.nlm.nih.gov/16080282>
205. Pfau, A., et al. Effective prophylaxis for recurrent urinary tract infections during pregnancy. *Clin Infect Dis*, 1992. 14: 810.
<https://pubmed.ncbi.nlm.nih.gov/1576275>
206. 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://pubmed.ncbi.nlm.nih.gov/10037399>
207. Scholes, D., et al. Risk factors associated with acute pyelonephritis in healthy women. *Ann Intern Med*, 2005. 142: 20.
<https://pubmed.ncbi.nlm.nih.gov/15630106>
208. Hill, J.B., et al. Acute pyelonephritis in pregnancy. *Obstet Gynecol*, 2005. 105: 18.
<https://pubmed.ncbi.nlm.nih.gov/15625136>
209. Fulop, T. Acute Pyelonephritis Workup. 2012.
210. 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://pubmed.ncbi.nlm.nih.gov/21034195>
211. Catrall, 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://pubmed.ncbi.nlm.nih.gov/30191339>
212. 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://pubmed.ncbi.nlm.nih.gov/21292654>
213. 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.2018.840/1079>
214. Hooton, T.M. Clinical practice. Uncomplicated urinary tract infection. *N Engl J Med*, 2012. 366: 1028.
<https://pubmed.ncbi.nlm.nih.gov/22417256>
215. 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://pubmed.ncbi.nlm.nih.gov/30420153>
216. 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://pubmed.ncbi.nlm.nih.gov/27887579>
217. 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://pubmed.ncbi.nlm.nih.gov/26994090>
218. 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://pubmed.ncbi.nlm.nih.gov/27107460>
219. 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://pubmed.ncbi.nlm.nih.gov/28575389>
220. 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://pubmed.ncbi.nlm.nih.gov/27313268>
221. 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://pubmed.ncbi.nlm.nih.gov/29486041>

222. 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://pubmed.ncbi.nlm.nih.gov/30270406>
223. Wagenlehner, F.M.E., *et al.* Once-Daily Plazomicin for Complicated Urinary Tract Infections. *N Engl J Med*, 2019. 380: 729.
<https://pubmed.ncbi.nlm.nih.gov/30786187>
224. 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://pubmed.ncbi.nlm.nih.gov/30509675>
225. Pitout, J.D. Infections with extended-spectrum beta-lactamase-producing enterobacteriaceae: changing epidemiology and drug treatment choices. *Drugs*, 2010. 70: 313.
<https://pubmed.ncbi.nlm.nih.gov/20166768>
226. 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://pubmed.ncbi.nlm.nih.gov/9892331>
227. Millar, L.K., *et al.* Outpatient treatment of pyelonephritis in pregnancy: a randomized controlled trial. *Obstet Gynecol*, 1995. 86: 560.
<https://pubmed.ncbi.nlm.nih.gov/7675380>
228. 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://pubmed.ncbi.nlm.nih.gov/9699761>
229. 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://pubmed.ncbi.nlm.nih.gov/12685882>
230. Reyner, K., *et al.* Urinary obstruction is an important complicating factor in patients with septic shock due to urinary infection. *Am J Emerg Med*, 2016. 34: 694.
<https://pubmed.ncbi.nlm.nih.gov/26905806>
231. Heyns, C.F. Urinary tract infection associated with conditions causing urinary tract obstruction and stasis, excluding urolithiasis and neuropathic bladder. *World J Urol*, 2012. 30: 77.
<https://pubmed.ncbi.nlm.nih.gov/21720861>
232. Spoorenberg, V., *et al.* [Better antibiotic use in complicated urinary tract infections; multicentre cluster randomised trial of 2 improvement strategies]. *Ned Tijdschr Geneesk*, 2016. 160: D460.
<https://pubmed.ncbi.nlm.nih.gov/27438395>
233. Bader, M.S., *et al.* An update on the management of urinary tract infections in the era of antimicrobial resistance. *Postgrad Med*, 2017. 129: 242.
<https://pubmed.ncbi.nlm.nih.gov/27712137>
234. 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>
235. 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://pubmed.ncbi.nlm.nih.gov/20175247>
236. Peterson, J., *et al.* Identification and pretherapy susceptibility of pathogens in patients with complicated urinary tract infection or acute pyelonephritis enrolled in a clinical study in the United States from November 2004 through April 2006. *Clin Ther*, 2007. 29: 2215.
<https://pubmed.ncbi.nlm.nih.gov/18042477>
237. Bader, M.S., *et al.* Management of complicated urinary tract infections in the era of antimicrobial resistance. *Postgrad Med*, 2010. 122: 7.
<https://pubmed.ncbi.nlm.nih.gov/21084776>
238. Wagenlehner, F., *et al.* The Global Prevalence of Infections in Urology Study: A Long-Term, Worldwide Surveillance Study on Urological Infections. *Pathogens*, 2016. 5.
<https://pubmed.ncbi.nlm.nih.gov/26797640>
239. 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>

240. Sternbach, N., *et al.* Efficacy and safety of ceftazidime/avibactam: a systematic review and meta-analysis. *J Antimicrob Chemother*, 2018. 73: 2021.
<https://pubmed.ncbi.nlm.nih.gov/29659836>
241. van der Starre, W.E., *et al.* Risk factors for fluoroquinolone-resistant *Escherichia coli* in adults with community-onset febrile urinary tract infection. *J Antimicrob Chemother*, 2011. 66: 650.
<https://pubmed.ncbi.nlm.nih.gov/21123286>
242. Ren, H., *et al.* Treatment of complicated urinary tract infection and acute pyelonephritis by short-course intravenous levofloxacin (750 mg/day) or conventional intravenous/oral levofloxacin (500 mg/day): prospective, open-label, randomized, controlled, multicenter, non-inferiority clinical trial. *Int Urol Nephrol*, 2017. 49: 499.
<https://pubmed.ncbi.nlm.nih.gov/28108978>
243. Wagenlehner, F.M., *et al.* Ceftolozane-tazobactam compared with levofloxacin in the treatment of complicated urinary-tract infections, including pyelonephritis: a randomised, double-blind, phase 3 trial (ASPECT-cUTI). *Lancet*, 2015. 385: 1949.
<https://pubmed.ncbi.nlm.nih.gov/25931244>
244. Rudrabhatla, P., *et al.* Stopping the effective non-fluoroquinolone antibiotics at day 7 vs continuing until day 14 in adults with acute pyelonephritis requiring hospitalization: A randomized non-inferiority trial. *PLoS One*, 2018. 13: e0197302.
<https://pubmed.ncbi.nlm.nih.gov/29768465>
245. Gould, C.V., *et al.* Guideline for prevention of catheter-associated urinary tract infections 2009. *Infect Control Hosp Epidemiol*, 2010. 31: 319.
<https://pubmed.ncbi.nlm.nih.gov/20156062>
246. Magill, S.S., *et al.* Multistate point-prevalence survey of health care-associated infections. *N Engl J Med*, 2014. 370: 1198.
<https://pubmed.ncbi.nlm.nih.gov/24670166>
247. Garibaldi, R.A., *et al.* Factors predisposing to bacteriuria during indwelling urethral catheterization. *N Engl J Med*, 1974. 291: 215.
<https://pubmed.ncbi.nlm.nih.gov/4834750>
248. Kunin, C.M., *et al.* Prevention of catheter-induced urinary-tract infections by sterile closed drainage. *N Engl J Med*, 1966. 274: 1155.
<https://pubmed.ncbi.nlm.nih.gov/5934951>
249. Hartstein, A.I., *et al.* Nosocomial urinary tract infection: a prospective evaluation of 108 catheterized patients. *Infect Control*, 1981. 2: 380.
<https://pubmed.ncbi.nlm.nih.gov/6795141>
250. 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://pubmed.ncbi.nlm.nih.gov/3572035>
251. 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://pubmed.ncbi.nlm.nih.gov/1863002>
252. Saint, S., *et al.* Preventing catheter-related bacteriuria: should we? Can we? How? *Arch Intern Med*, 1999. 159: 800.
<https://pubmed.ncbi.nlm.nih.gov/10219925>
253. Maki, D.G., *et al.* Engineering out the risk for infection with urinary catheters. *Emerg Infect Dis*, 2001. 7: 342.
<https://pubmed.ncbi.nlm.nih.gov/11294737>
254. 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://pubmed.ncbi.nlm.nih.gov/30259542>
255. 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://pubmed.ncbi.nlm.nih.gov/18202436>
256. 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://pubmed.ncbi.nlm.nih.gov/28982611>
257. 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://pubmed.ncbi.nlm.nih.gov/25775048>
258. Meddings, J., *et al.* Systematic Review of Interventions to Reduce Urinary Tract Infection in Nursing Home Residents. *J Hosp Med*, 2017. 12: 356.
<https://pubmed.ncbi.nlm.nih.gov/28459908>

259. Kachare, S.D., *et al.* Toward eliminating catheter-associated urinary tract infections in an academic health center. *J Surg Res*, 2014. 192: 280.
<https://pubmed.ncbi.nlm.nih.gov/25150082>
260. 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://pubmed.ncbi.nlm.nih.gov/30243912>
261. Noto, M.J., *et al.* Chlorhexidine bathing and health care-associated infections: a randomized clinical trial. *JAMA*, 2015. 313: 369.
<https://pubmed.ncbi.nlm.nih.gov/25602496>
262. 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://pubmed.ncbi.nlm.nih.gov/27048258>
263. 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://pubmed.ncbi.nlm.nih.gov/30834958>
264. 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://pubmed.ncbi.nlm.nih.gov/30056015>
265. 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://pubmed.ncbi.nlm.nih.gov/26661940>
266. 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://pubmed.ncbi.nlm.nih.gov/24249436>
267. Kranz, J., *et al.* Catheter-Associated Urinary Tract Infections in Adult Patients. *Dtsch Arztebl Int*, 2020. 117: 83.
<https://pubmed.ncbi.nlm.nih.gov/32102727>
268. 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://pubmed.ncbi.nlm.nih.gov/28073354>
269. 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://pubmed.ncbi.nlm.nih.gov/29928619>
270. 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://pubmed.ncbi.nlm.nih.gov/31030965>
271. 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://pubmed.ncbi.nlm.nih.gov/30145671>
272. 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://pubmed.ncbi.nlm.nih.gov/25248140>
273. 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://pubmed.ncbi.nlm.nih.gov/30451342>
274. 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://pubmed.ncbi.nlm.nih.gov/28578163>
275. Lusardi, G., *et al.* Antibiotic prophylaxis for short-term catheter bladder drainage in adults. *Cochrane Database Syst Rev*, 2013. 2013: CD005428.
<https://pubmed.ncbi.nlm.nih.gov/23824735>
276. 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://pubmed.ncbi.nlm.nih.gov/29766842>
277. 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://pubmed.ncbi.nlm.nih.gov/24452449>
278. 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://pubmed.ncbi.nlm.nih.gov/24035770>

279. Saint, S., *et al.* Preventing Catheter-Associated Urinary Tract Infections. *N Engl J Med*, 2016. 375: 1298.
<https://pubmed.ncbi.nlm.nih.gov/27682041>
280. Bone, R.C., *et al.* Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. The ACCP/SCCM Consensus Conference Committee. American College of Chest Physicians/Society of Critical Care Medicine. *Chest*, 1992. 101: 1644.
<https://pubmed.ncbi.nlm.nih.gov/1303622>
281. Levy, M.M., *et al.* 2001 SCCM/ESICM/ACCP/ATS/SIS International Sepsis Definitions Conference. *Crit Care Med*, 2003. 31: 1250.
<https://pubmed.ncbi.nlm.nih.gov/12682500>
282. Dellinger, R.P., *et al.* Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock, 2012. *Intensive Care Med*, 2013. 39: 165.
<https://pubmed.ncbi.nlm.nih.gov/23361625>
283. Martin, G.S., *et al.* The epidemiology of sepsis in the United States from 1979 through 2000. *N Engl J Med*, 2003. 348: 1546.
<https://pubmed.ncbi.nlm.nih.gov/12700374>
284. Hotchkiss, R.S., *et al.* The pathophysiology and treatment of sepsis. *N Engl J Med*, 2003. 348: 138.
<https://pubmed.ncbi.nlm.nih.gov/12519925>
285. Rosser, C.J., *et al.* Urinary tract infections in the critically ill patient with a urinary catheter. *Am J Surg*, 1999. 177: 287.
<https://pubmed.ncbi.nlm.nih.gov/10326844>
286. Brun-Buisson, C., *et al.* EPISEPSIS: a reappraisal of the epidemiology and outcome of severe sepsis in French intensive care units. *Intensive Care Med*, 2004. 30: 580.
<https://pubmed.ncbi.nlm.nih.gov/14997295>
287. Tandogdu, Z., *et al.* Antimicrobial resistance in urosepsis: outcomes from the multinational, multicenter global prevalence of infections in urology (GPIU) study 2003-2013. *World J Urol*, 2016. 34: 1193.
<https://pubmed.ncbi.nlm.nih.gov/26658886>
288. Wilson, M.L., *et al.* Principles and procedures for blood cultures; Approved Guideline. Clinical and Laboratory Standards Institute, 2007.
https://clsi.org/media/1448/m47a_sample.pdf
289. Howell, M.D., *et al.* Management of Sepsis and Septic Shock. *JAMA*, 2017. 317: 847.
<https://pubmed.ncbi.nlm.nih.gov/28114603>
290. Brunkhorst, F.M., *et al.* Procalcitonin for early diagnosis and differentiation of SIRS, sepsis, severe sepsis, and septic shock. *Intensive Care Med*, 2000. 26 Suppl 2: S148.
<https://pubmed.ncbi.nlm.nih.gov/18470710>
291. Angeletti, S., *et al.* Procalcitonin, MR-Proadrenomedullin, and Cytokines Measurement in Sepsis Diagnosis: Advantages from Test Combination. *Dis Markers*, 2015. 2015: 951532.
<https://pubmed.ncbi.nlm.nih.gov/26635427>
292. Harbarth, S., *et al.* Diagnostic value of procalcitonin, interleukin-6, and interleukin-8 in critically ill patients admitted with suspected sepsis. *Am J Respir Crit Care Med*, 2001. 164: 396.
<https://pubmed.ncbi.nlm.nih.gov/11500339>
293. Mikkelsen, M.E., *et al.* Serum lactate is associated with mortality in severe sepsis independent of organ failure and shock. *Crit Care Med*, 2009. 37: 1670.
<https://pubmed.ncbi.nlm.nih.gov/19325467>
294. Carlet, J., *et al.* Guidelines for prevention of nosocomial infections in intensive care unit. *Arnette Ed Paris* 1994: 41.
295. Riedl, C.R., *et al.* Bacterial colonization of ureteral stents. *Eur Urol*, 1999. 36: 53.
<https://pubmed.ncbi.nlm.nih.gov/10364656>
296. DeGroot-Kosolcharoen, J., *et al.* Evaluation of a urinary catheter with a preconnected closed drainage bag. *Infect Control Hosp Epidemiol*, 1988. 9: 72.
<https://pubmed.ncbi.nlm.nih.gov/3343502>
297. Rivers, E., *et al.* Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med*, 2001. 345: 1368.
<https://pubmed.ncbi.nlm.nih.gov/11794169>
298. Mouncey, P.R., *et al.* Trial of early, goal-directed resuscitation for septic shock. *N Engl J Med*, 2015. 372: 1301.
<https://pubmed.ncbi.nlm.nih.gov/25776532>
299. Investigators, A., *et al.* Goal-directed resuscitation for patients with early septic shock. *N Engl J Med*, 2014. 371: 1496.
<https://pubmed.ncbi.nlm.nih.gov/25272316>

300. Pro, C.I., *et al.* A randomized trial of protocol-based care for early septic shock. *N Engl J Med*, 2014. 370: 1683.
<https://pubmed.ncbi.nlm.nih.gov/24635773>
301. Investigators, P., *et al.* Early, Goal-Directed Therapy for Septic Shock - A Patient-Level Meta-Analysis. *N Engl J Med*, 2017. 376: 2223.
<https://pubmed.ncbi.nlm.nih.gov/28320242>
302. Monnet, X., *et al.* Prediction of fluid responsiveness: an update. *Ann Intensive Care*, 2016. 6: 111.
<https://pubmed.ncbi.nlm.nih.gov/27858374>
303. Dellinger, R.P., *et al.* Surviving Sepsis Campaign guidelines for management of severe sepsis and septic shock. *Crit Care Med*, 2004. 32: 858.
<https://pubmed.ncbi.nlm.nih.gov/15090974>
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://pubmed.ncbi.nlm.nih.gov/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://pubmed.ncbi.nlm.nih.gov/27147267>
306. Workowski, K.A., *et al.* Sexually transmitted diseases treatment guidelines, 2015. *MMWR Recomm Rep*, 2015. 64: 1.
<https://pubmed.ncbi.nlm.nih.gov/26042815>
307. Bartoletti, R., *et al.* Management of Urethritis: Is It Still the Time for Empirical Antibiotic Treatments? *Eur Urol Focus*, 2019. 5: 29.
<https://pubmed.ncbi.nlm.nih.gov/30318465>
308. Jensen, J.S., *et al.* 2016 European guideline on Mycoplasma genitalium infections. *J Eur Acad Dermatol Venereol*, 2016. 30: 1650.
<https://pubmed.ncbi.nlm.nih.gov/27505296>
309. 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://pubmed.ncbi.nlm.nih.gov/29955859>
310. Wagenlehner, F.M., *et al.* The Presentation, Diagnosis, and Treatment of Sexually Transmitted Infections. *Dtsch Arztebl Int*, 2016. 113: 11.
<https://pubmed.ncbi.nlm.nih.gov/26931526>
311. 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://pubmed.ncbi.nlm.nih.gov/24555561>
312. Shigemura, K., *et al.* History and epidemiology of antibiotic susceptibilities of Neisseria gonorrhoeae. *Curr Drug Targets*, 2015. 16: 272.
<https://pubmed.ncbi.nlm.nih.gov/25410409>
313. Hathorn, E., *et al.* The effectiveness of gentamicin in the treatment of Neisseria gonorrhoeae: a systematic review. *Syst Rev*, 2014. 3: 104.
<https://pubmed.ncbi.nlm.nih.gov/25239090>
314. Lau, A., *et al.* The Efficacy of Azithromycin for the Treatment of Genital Mycoplasma genitalium: A Systematic Review and Meta-analysis. *Clin Infect Dis*, 2015. 61: 1389.
<https://pubmed.ncbi.nlm.nih.gov/26240201>
315. Manhart, L.E., *et al.* Efficacy of Antimicrobial Therapy for Mycoplasma genitalium Infections. *Clin Infect Dis*, 2015. 61 Suppl 8: S802.
<https://pubmed.ncbi.nlm.nih.gov/26602619>
316. Paez-Canro, C., *et al.* Antibiotics for treating urogenital Chlamydia trachomatis infection in men and non-pregnant women. *Cochrane Database Syst Rev*, 2019. 1: CD010871.
<https://pubmed.ncbi.nlm.nih.gov/30682211>
317. 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://pubmed.ncbi.nlm.nih.gov/26092579>
318. 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://pubmed.ncbi.nlm.nih.gov/28159916>
319. 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://pubmed.ncbi.nlm.nih.gov/28705094>

320. Moi, H., *et al.* Microscopy of Stained Urethral Smear in Male Urethritis; Which Cutoff Should be Used? *Sex Transm Dis*, 2017. 44: 189.
<https://pubmed.ncbi.nlm.nih.gov/28178118>
321. 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://pubmed.ncbi.nlm.nih.gov/30238498>
322. Falk, L., *et al.* Time to eradication of *Mycoplasma genitalium* after antibiotic treatment in men and women. *J Antimicrob Chemother*, 2015. 70: 3134.
<https://pubmed.ncbi.nlm.nih.gov/26283670>
323. 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://pubmed.ncbi.nlm.nih.gov/25616607>
324. Kirkcaldy, R.D., *et al.* *Neisseria gonorrhoeae* Antimicrobial Susceptibility Surveillance - The Gonococcal Isolate Surveillance Project, 27 Sites, United States, 2014. *MMWR Surveill Summ*, 2016. 65: 1.
<https://pubmed.ncbi.nlm.nih.gov/27414503>
325. 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://pubmed.ncbi.nlm.nih.gov/28079749>
326. Read, T.R., *et al.* Azithromycin 1.5g Over 5 Days Compared to 1g Single Dose in Urethral *Mycoplasma genitalium*: Impact on Treatment Outcome and Resistance. *Clin Infect Dis*, 2017. 64: 250.
<https://pubmed.ncbi.nlm.nih.gov/28011607>
327. Read, T.R.H., *et al.* Use of Pristinamycin for Macrolide-Resistant *Mycoplasma genitalium* Infection. *Emerg Infect Dis*, 2018. 24: 328.
<https://pubmed.ncbi.nlm.nih.gov/29350154>
328. Salado-Rasmussen, K., *et al.* *Mycoplasma genitalium* testing pattern and macrolide resistance: a Danish nationwide retrospective survey. *Clin Infect Dis*, 2014. 59: 24.
<https://pubmed.ncbi.nlm.nih.gov/24729494>
329. 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://pubmed.ncbi.nlm.nih.gov/29038284>
330. 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://pubmed.ncbi.nlm.nih.gov/27025738>
331. Unemo, M., *et al.* Five-day Azithromycin Treatment Regimen for *Mycoplasma genitalium* Infection Also Effectively Eradicates *Chlamydia trachomatis*. *Acta Derm Venereol*, 2015. 95: 730.
<https://pubmed.ncbi.nlm.nih.gov/25823977>
332. 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://pubmed.ncbi.nlm.nih.gov/24948703>
333. 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://pubmed.ncbi.nlm.nih.gov/27064136>
334. 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://pubmed.ncbi.nlm.nih.gov/20215624>
335. 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://pubmed.ncbi.nlm.nih.gov/20498103>
336. 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://pubmed.ncbi.nlm.nih.gov/22183839>
337. 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://pubmed.ncbi.nlm.nih.gov/24622331>
338. Bissessor, M., *et al.* Macrolide resistance and azithromycin failure in a *Mycoplasma genitalium*-infected cohort and response of azithromycin failures to alternative antibiotic regimens. *Clin Infect Dis*, 2015. 60: 1228.
<https://pubmed.ncbi.nlm.nih.gov/25537875>

339. Kirkcaldy, R.D., *et al.* The efficacy and safety of gentamicin plus azithromycin and gemifloxacin plus azithromycin as treatment of uncomplicated gonorrhoea. *Clin Infect Dis*, 2014. 59: 1083.
<https://pubmed.ncbi.nlm.nih.gov/25031289>
340. 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://pubmed.ncbi.nlm.nih.gov/18539003>
341. Lanjouw, E., *et al.* 2015 European guideline on the management of Chlamydia trachomatis infections. *Int J STD AIDS*, 2016. 27: 333.
<https://pubmed.ncbi.nlm.nih.gov/26608577>
342. Lau, C.Y., *et al.* Azithromycin versus doxycycline for genital chlamydial infections: a meta-analysis of randomized clinical trials. *Sex Transm Dis*, 2002. 29: 497.
<https://pubmed.ncbi.nlm.nih.gov/12218839>
343. Moran, J.S., *et al.* Drugs of choice for the treatment of uncomplicated gonococcal infections. *Clin Infect Dis*, 1995. 20 Suppl 1: S47.
<https://pubmed.ncbi.nlm.nih.gov/7795109>
344. Unemo, M., *et al.* Antimicrobial resistance in Neisseria gonorrhoeae in the 21st century: past, evolution, and future. *Clin Microbiol Rev*, 2014. 27: 587.
<https://pubmed.ncbi.nlm.nih.gov/24982323>
345. 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://pubmed.ncbi.nlm.nih.gov/18665871>
346. 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://pubmed.ncbi.nlm.nih.gov/9801092>
347. Alexander, R.B., *et al.* Chronic prostatitis: results of an Internet survey. *Urology*, 1996. 48: 568.
<https://pubmed.ncbi.nlm.nih.gov/8886062>
348. Zermann, D.H., *et al.* Neurourological insights into the etiology of genitourinary pain in men. *J Urol*, 1999. 161: 903.
<https://pubmed.ncbi.nlm.nih.gov/10022711>
349. Perletti, G., *et al.* Antimicrobial therapy for chronic bacterial prostatitis. *Cochrane Database Syst Rev*, 2013: CD009071.
<https://pubmed.ncbi.nlm.nih.gov/23934982>
350. Dadashpour, M., *et al.* Acute Prostatitis After Transrectal Ultrasound-guided Prostate Biopsy: Comparing Two Different Antibiotic Prophylaxis Regimen. *Biomedical & Pharmacology Journal*, 2016. 9: 593.
<https://biomedpharmajournal.org/vol9no2/acute-prostatitis-after-transrectal-ultrasound-guided-prostate-biopsy-comparing-two-different-antibiotic-prophylaxis-regimen/>
351. 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://pubmed.ncbi.nlm.nih.gov/15947609>
352. 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://pubmed.ncbi.nlm.nih.gov/12727080>
353. 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://pubmed.ncbi.nlm.nih.gov/21123162>
354. Cai, T., *et al.* Serenoa repens associated with Urtica dioica (ProstaMEV) and curcumin and quercetin (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://pubmed.ncbi.nlm.nih.gov/19181486>
355. Aliaev lu, G., *et al.* [Wardenafil in combined treatment of patients with chronic bacterial prostatitis]. *Urologiia*, 2008: 52.
<https://pubmed.ncbi.nlm.nih.gov/19256057>
356. Lipsky, B.A., *et al.* Treatment of bacterial prostatitis. *Clin Infect Dis*, 2010. 50: 1641.
<https://pubmed.ncbi.nlm.nih.gov/20459324>
357. 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>
358. Turner, J.A., *et al.* Validity and responsiveness of the national institutes of health chronic prostatitis symptom index. *J Urol*, 2003. 169: 580.
<https://pubmed.ncbi.nlm.nih.gov/12544311>

359. 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://pubmed.ncbi.nlm.nih.gov/18341719>
360. 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://pubmed.ncbi.nlm.nih.gov/16916775>
361. Skerk, V., *et al.* The role of unusual pathogens in prostatitis syndrome. *Int J Antimicrob Agents*, 2004. 24 Suppl 1: S53.
<https://pubmed.ncbi.nlm.nih.gov/15364308>
362. 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://pubmed.ncbi.nlm.nih.gov/14535851>
363. Naber, K.G., *et al.*, Prostatitis, epididymitis and orchitis, in *Infectious diseases*, D. Armstrong & J. Cohen, Editors. 1999, Mosby: London.
364. Badalyan, R.R., *et al.* Chlamydial and ureaplasma infections in patients with nonbacterial chronic prostatitis. *Andrologia*, 2003. 35: 263.
<https://pubmed.ncbi.nlm.nih.gov/14535852>
365. 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.
366. Robinson, A.J., *et al.* Acute epididymitis: why patient and consort must be investigated. *Br J Urol*, 1990. 66: 642.
<https://pubmed.ncbi.nlm.nih.gov/2265337>
367. Schaeffer, A.J. Prostatitis: US perspective. *Int J Antimicrob Agents*, 1999. 11: 205.
<https://pubmed.ncbi.nlm.nih.gov/10394972>
368. Krieger, J.N., *et al.* NIH consensus definition and classification of prostatitis. *JAMA*, 1999. 282: 236.
<https://pubmed.ncbi.nlm.nih.gov/10422990>
369. (NIDDK), W.C.o.t.N.I.o.D.a.D.a.K.D., Chronic prostatitis workshop. 1995: Bethesda, Maryland.
370. Krieger, J.N., *et al.* Chronic pelvic pains represent the most prominent urogenital symptoms of “chronic prostatitis”. *Urology*, 1996. 48: 715.
<https://pubmed.ncbi.nlm.nih.gov/8911515>
371. Nickel, J.C. Effective office management of chronic prostatitis. *Urol Clin North Am*, 1998. 25: 677.
<https://pubmed.ncbi.nlm.nih.gov/10026774>
372. 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://pubmed.ncbi.nlm.nih.gov/18288905>
373. Meares, E.M., *et al.* Bacteriologic localization patterns in bacterial prostatitis and urethritis. *Invest Urol*, 1968. 5: 492.
<https://pubmed.ncbi.nlm.nih.gov/4870505>
374. 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://pubmed.ncbi.nlm.nih.gov/16753385>
375. Doble, A., *et al.* Ultrasonographic findings in prostatitis. *Urol Clin North Am*, 1989. 16: 763.
<https://pubmed.ncbi.nlm.nih.gov/2683305>
376. Papp, J.R., *et al.* Recommendations for the Laboratory-Based Detection of Chlamydia trachomatis and Neisseria gonorrhoeae – 2014. *MMWR. Recommendations and reports : Morbidity and mortality weekly report. Recommendations and reports / Centers for Disease Control*, 2014. 63: 1.
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4047970/>
377. 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://pubmed.ncbi.nlm.nih.gov/10411025>
378. Wagenlehner, F.M., *et al.* Bacterial prostatitis. *World J Urol*, 2013. 31: 711.
<https://pubmed.ncbi.nlm.nih.gov/23519458>
379. Gill, B.C., *et al.* Bacterial prostatitis. *Curr Opin Infect Dis*, 2016. 29: 86.
<https://pubmed.ncbi.nlm.nih.gov/26555038>
380. Wagenlehner, F.M., *et al.* Prostatitis: the role of antibiotic treatment. *World J Urol*, 2003. 21: 105.
<https://pubmed.ncbi.nlm.nih.gov/12687400>
381. Krieger, J.N. Recurrent lower urinary tract infections in men. *J New Rem Clin*, 1998. 47: 4.
382. 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://pubmed.ncbi.nlm.nih.gov/10411041>

383. 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?via%3Dihub>
384. 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://pubmed.ncbi.nlm.nih.gov/9831786>
385. 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://pubmed.ncbi.nlm.nih.gov/20383345>
386. 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://pubmed.ncbi.nlm.nih.gov/16026425>
387. 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://pubmed.ncbi.nlm.nih.gov/8249222>
388. Jimenez-Cruz, J.F., *et al.* Treatment of chronic prostatitis: intraprostatic antibiotic injections under echography control. *J Urol*, 1988. 139: 967.
<https://pubmed.ncbi.nlm.nih.gov/3283385>
389. 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://pubmed.ncbi.nlm.nih.gov/10096759>
390. Hua, L.X., *et al.* [The diagnosis and treatment of acute prostatitis: report of 35 cases]. *Zhonghua Nan Ke Xue*, 2005. 11: 897.
<https://pubmed.ncbi.nlm.nih.gov/16398358>
391. Yoon, B.I., *et al.* Acute bacterial prostatitis: how to prevent and manage chronic infection? *J Infect Chemother*, 2012. 18: 444.
<https://pubmed.ncbi.nlm.nih.gov/22215226>
392. Ludwig, M., *et al.* Diagnosis and therapeutic management of 18 patients with prostatic abscess. *Urology*, 1999. 53: 340.
<https://pubmed.ncbi.nlm.nih.gov/9933051>
393. Chou, Y.H., *et al.* Prostatic abscess: transrectal color Doppler ultrasonic diagnosis and minimally invasive therapeutic management. *Ultrasound Med Biol*, 2004. 30: 719.
<https://pubmed.ncbi.nlm.nih.gov/15219951>
394. 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>
395. Pilatz, A., *et al.* Acute epididymitis revisited: impact of molecular diagnostics on etiology and contemporary guideline recommendations. *Eur Urol*, 2015. 68: 428.
<https://pubmed.ncbi.nlm.nih.gov/25542628>
396. Harnisch, J.P., *et al.* Aetiology of acute epididymitis. *Lancet*, 1977. 1: 819.
<https://pubmed.ncbi.nlm.nih.gov/67333>
397. 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://pubmed.ncbi.nlm.nih.gov/30949801>
398. Street, E., *et al.* The 2016 European guideline on the management of epididymo-orchitis. *IUSTI*, 2016.
<https://pubmed.ncbi.nlm.nih.gov/28632112>
399. 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://pubmed.ncbi.nlm.nih.gov/34009058>
400. Abbara, A., *et al.* Etiology and management of genitourinary tuberculosis. *Nat Rev Urol*, 2011. 8: 678.
<https://pubmed.ncbi.nlm.nih.gov/22157940>
401. 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://pubmed.ncbi.nlm.nih.gov/32214857>
402. 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://pubmed.ncbi.nlm.nih.gov/30600755>

403. Sadahira, T., *et al.* Clinical pharmacokinetics of oral levofloxacin and sitafloxacin in epididymal tissue. *J Infect Chemother*, 2017. 23: 214.
<https://pubmed.ncbi.nlm.nih.gov/28089362>
404. Street, E., *et al.* BASHH 2010 United Kingdom national guideline for the management of epididymo-orchitis. 2010.
<https://pubmed.ncbi.nlm.nih.gov/21729951>
405. Fifer, H., *et al.* 2018 UK national guideline for the management of infection with *Neisseria gonorrhoeae*. *Int J STD AIDS*, 2020. 31: 4.
<https://pubmed.ncbi.nlm.nih.gov/31870237>
406. 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://pubmed.ncbi.nlm.nih.gov/10532980>
407. Banyra, O., *et al.* Acute epididymo-orchitis: relevance of local classification and partner's follow-up. *Cent European J Urol*, 2019. 72: 324.
<https://pubmed.ncbi.nlm.nih.gov/31720038>
408. Pilatz, A., *et al.* Impact of Bacterial Epididymitis on Semen Quality after Antibiotic Treatment. *Journal of Urology*, 2012. 187: e443.
https://university.auanet.org/abstract_detail.cfm?id=1092&meetingID=12ATL
409. 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_Comparative_regional_audit_of_urology_and_genito-urinary_departments_in_the_management_of_acute_epididymo-orchitis
410. 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://pubmed.ncbi.nlm.nih.gov/20883615>
411. 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://pubmed.ncbi.nlm.nih.gov/21097811>
412. Chennamsetty, A., *et al.* Contemporary diagnosis and management of Fournier's gangrene. *Ther Adv Urol*, 2015. 7: 203.
<https://pubmed.ncbi.nlm.nih.gov/26445600>
413. Eke, N. Fournier's gangrene: a review of 1726 cases. *Br J Surg*, 2000. 87: 718.
<https://pubmed.ncbi.nlm.nih.gov/10848848>
414. Subrahmanyam, U., *et al.* Honey dressing beneficial in treatment of Fournier's gangrene. *Indian J Surg*, 2004. 66: 75.
https://tspace.library.utoronto.ca/retrieve/4733/IndianJournalofSurgery_2004_66_2_75_12453.pdf
415. Jallali, N., *et al.* Hyperbaric oxygen as adjuvant therapy in the management of necrotizing fasciitis. *American Journal of Surgery*, 2005. 189: 462.
<https://pubmed.ncbi.nlm.nih.gov/15820462>
416. Karian, L.S., *et al.* Reconstruction of Defects After Fournier Gangrene: A Systematic Review. *Eplasty*, 2015. 15: e18.
<https://pubmed.ncbi.nlm.nih.gov/26171090>
417. 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://pubmed.ncbi.nlm.nih.gov/27693572>
418. Kim, S.Y., *et al.* A contemporary analysis of Fournier gangrene using the National Surgical Quality Improvement Program. *Urology*, 2015. 85: 1052.
<https://pubmed.ncbi.nlm.nih.gov/25770725>
419. Sorensen, M.D., *et al.* Fournier's Gangrene: Epidemiology and Outcomes in the General US Population. *Urol Int*, 2016. 97: 249.
<https://pubmed.ncbi.nlm.nih.gov/27172977>
420. 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>
421. 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://pubmed.ncbi.nlm.nih.gov/28538648>
422. 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>

423. 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://pubmed.ncbi.nlm.nih.gov/24947530>
424. 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://pubmed.ncbi.nlm.nih.gov/29121862>
425. 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://pubmed.ncbi.nlm.nih.gov/30309014>
426. 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://pubmed.ncbi.nlm.nih.gov/21908729>
427. 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://pubmed.ncbi.nlm.nih.gov/29759898>
428. Luttmmer, R., *et al.* Presence of human papillomavirus in semen in relation to semen quality. *Hum Reprod*, 2016. 31: 280.
<https://pubmed.ncbi.nlm.nih.gov/26724799>
429. Souho, T., *et al.* Human papillomavirus infection and fertility alteration: a systematic review. *PLoS One*, 2015. 10: e0126936.
<https://pubmed.ncbi.nlm.nih.gov/25992782>
430. 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://pubmed.ncbi.nlm.nih.gov/28485812>
431. 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://pubmed.ncbi.nlm.nih.gov/30852604>
432. Harder, T., *et al.* Efficacy, effectiveness and safety of vaccination against human papillomavirus in males: a systematic review. *BMC Med*, 2018. 16: 110.
<https://pubmed.ncbi.nlm.nih.gov/30016957>
433. 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://pubmed.ncbi.nlm.nih.gov/27635177>
434. 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://pubmed.ncbi.nlm.nih.gov/29909908>
435. 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://pubmed.ncbi.nlm.nih.gov/26526324>
436. Geskus Rb, G.C.T.M.D.R.J.V.P.M.M.I.M.D.S.S.H.-N.B.O.M.D.A.J. 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>
437. 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://pubmed.ncbi.nlm.nih.gov/25088239>
438. 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://pubmed.ncbi.nlm.nih.gov/24935346>
439. 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://pubmed.ncbi.nlm.nih.gov/26204471>
440. 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://pubmed.ncbi.nlm.nih.gov/27301867>
441. 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://pubmed.ncbi.nlm.nih.gov/23327450>

442. 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://pubmed.ncbi.nlm.nih.gov/24488594>
443. 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://pubmed.ncbi.nlm.nih.gov/21965090>
444. 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://pubmed.ncbi.nlm.nih.gov/26433493>
445. Albero, G., *et al.* Male circumcision and genital human papillomavirus: a systematic review and meta-analysis. *Sex Transm Dis*, 2012. 39: 104.
<https://pubmed.ncbi.nlm.nih.gov/22249298>
446. 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://pubmed.ncbi.nlm.nih.gov/12736026>
447. Vives, A., *et al.* Urethral condylomas in men: experience in 123 patients without previous treatment. *Int J STD AIDS*, 2016. 27: 39.
<https://pubmed.ncbi.nlm.nih.gov/25712107>
448. Gilson, R., *et al.* 2019 IUSTI-Europe guideline for the management of anogenital warts. *J Eur Acad Dermatol Venereol*, 2020. 34: 1644.
<https://pubmed.ncbi.nlm.nih.gov/32735077>
449. 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://pubmed.ncbi.nlm.nih.gov/9449906>
450. 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://pubmed.ncbi.nlm.nih.gov/19466962>
451. Grillo-Ardila, C.F., *et al.* Imiquimod for anogenital warts in non-immunocompromised adults. *Cochrane Database Syst Rev*, 2014: CD010389.
<https://pubmed.ncbi.nlm.nih.gov/25362229>
452. 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://pubmed.ncbi.nlm.nih.gov/18515521>
453. Puviani, M., *et al.* Efficacy of sinecatechins 10% as proactive sequential therapy of external genital warts after laser CO₂ 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://pubmed.ncbi.nlm.nih.gov/30236042>
454. 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://pubmed.ncbi.nlm.nih.gov/27803240>
455. 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://pubmed.ncbi.nlm.nih.gov/24770498>
456. Kodner, C.M., *et al.* Management of genital warts. *Am Fam Physician*, 2004. 70: 2335.
<https://pubmed.ncbi.nlm.nih.gov/15617297>
457. Scheinfeld, N., *et al.* An evidence-based review of medical and surgical treatments of genital warts. *Dermatol Online J*, 2006. 12: 5.
<https://pubmed.ncbi.nlm.nih.gov/16638419>
458. 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://pubmed.ncbi.nlm.nih.gov/31676644>
459. 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://pubmed.ncbi.nlm.nih.gov/19321868>
460. Schmeler, K.M., *et al.* Expanding the benefits of HPV vaccination to boys and men. *Lancet*, 2016. 387: 1798.
<https://pubmed.ncbi.nlm.nih.gov/27203488>
461. Rosales, R., *et al.* Regression of human papillomavirus intraepithelial lesions is induced by MVA E2 therapeutic vaccine. *Hum Gene Ther*, 2014. 25: 1035.
<https://pubmed.ncbi.nlm.nih.gov/25275724>

462. 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://pubmed.ncbi.nlm.nih.gov/30797638>
463. 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://pubmed.ncbi.nlm.nih.gov/31755549>
464. 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://pubmed.ncbi.nlm.nih.gov/31090474>
465. Richman Ar, T.E.G.E.J. A randomized intervention study to evaluate whether electronic messaging can increase HPV vaccine uptake and knowledge. *Journal of lower genital tract disease*, 2016. 20: S28.
https://journals.lww.com/jlgttd/Fulltext/2016/04001/2016_ASCCP_Poster_Presentation_Abstracts.2.aspx
466. European Center for Disease Prevention 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>
467. Hayward, S.E., *et al.* Extrapulmonary tuberculosis among migrants in Europe, 1995 to 2017. *Clin Microbiol Infect*, 2021. 27: 1347 e1.
<https://pubmed.ncbi.nlm.nih.gov/33352301>
468. Lawn, S.D., *et al.* Tuberculosis. *Lancet*, 2011. 378: 57.
<https://pubmed.ncbi.nlm.nih.gov/21420161>
469. 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://pubmed.ncbi.nlm.nih.gov/34781005>
470. 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://pubmed.ncbi.nlm.nih.gov/9363017>
471. 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>
472. 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://pubmed.ncbi.nlm.nih.gov/28052967>
473. 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/en/publications-data/mastering-basics-tb-control-development-handbook-tb-diagnostic-methods>
474. 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://pubmed.ncbi.nlm.nih.gov/27175652>
475. 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>
476. 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://pubmed.ncbi.nlm.nih.gov/20132626>
477. 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/home/article_abstract/709
478. World Health Organization. WHO consolidated guidelines on tuberculosis. Module 3: diagnosis - rapid diagnostics for tuberculosis detection 2021 update. ISBN 978-92-4-002941-5 <https://www.who.int/publications/i/item/9789240029415>
479. 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.
<https://apps.who.int/iris/handle/10665/334150>
480. 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://pubmed.ncbi.nlm.nih.gov/11018606>

481. Muttarak, M., *et al.* Tuberculous epididymitis and epididymo-orchitis: sonographic appearances. *AJR Am J Roentgenol*, 2001. 176: 1459.
<https://pubmed.ncbi.nlm.nih.gov/11373214>
482. 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://pubmed.ncbi.nlm.nih.gov/12562118>
483. 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://pubmed.ncbi.nlm.nih.gov/34079716>
484. 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://pubmed.ncbi.nlm.nih.gov/30882677>
485. Yang, D.M., *et al.* Chronic tuberculous epididymitis: color Doppler US findings with histopathologic correlation. *Abdom Imaging*, 2000. 25: 559.
<https://pubmed.ncbi.nlm.nih.gov/10931999>
486. Rui, X., *et al.* Ultrasonographic diagnosis and typing of renal tuberculosis. *Int J Urol*, 2008. 15: 135.
<https://pubmed.ncbi.nlm.nih.gov/18269447>
487. Radwan, A., *et al.* Multimodality Imaging of Genitourinary Tuberculosis. *Curr Probl Diagn Radiol*, 2021. 50: 867.
<https://pubmed.ncbi.nlm.nih.gov/33272721>
488. Baumgarten, D.A., *et al.* Imaging and radiologic management of upper urinary tract infections. *Urol Clin North Am*, 1997. 24: 545.
<https://pubmed.ncbi.nlm.nih.gov/9275978>
489. Muttarak, M., *et al.* Tuberculosis of the genitourinary tract: imaging features with pathological correlation. *Singapore Med J*, 2005. 46: 568.
<https://pubmed.ncbi.nlm.nih.gov/16172781>
490. 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://pubmed.ncbi.nlm.nih.gov/26614184>
491. 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://pubmed.ncbi.nlm.nih.gov/25879600>
492. Wang, L.J., *et al.* Imaging findings of urinary tuberculosis on excretory urography and computerized tomography. *J Urol*, 2003. 169: 524.
<https://pubmed.ncbi.nlm.nih.gov/12544301>
493. 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://pubmed.ncbi.nlm.nih.gov/2370364>
494. Jung, Y.Y., *et al.* Genitourinary tuberculosis: comprehensive cross-sectional imaging. *AJR Am J Roentgenol*, 2005. 184: 143.
<https://pubmed.ncbi.nlm.nih.gov/15615965>
495. Wang, L.J., *et al.* CT features of genitourinary tuberculosis. *J Comput Assist Tomogr*, 1997. 21: 254.
<https://pubmed.ncbi.nlm.nih.gov/9071295>
496. Sharma, J.B., *et al.* Female genital tuberculosis: Revisited. *Indian J Med Res*, 2018. 148: S71.
<https://pubmed.ncbi.nlm.nih.gov/30964083>
497. Mantica, G., *et al.* Genitourinary Tuberculosis: A Comprehensive Review of a Neglected Manifestation in Low-Endemic Countries. *Antibiotics (Basel)*, 2021. 10.
<https://pubmed.ncbi.nlm.nih.gov/34827337>
498. 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://pubmed.ncbi.nlm.nih.gov/26185345>
499. Cheng, Y., *et al.* Multiparametric Magnetic Resonance Imaging Characteristics of Prostate Tuberculosis. *Korean J Radiol*, 2015. 16: 846.
<https://pubmed.ncbi.nlm.nih.gov/26175584>
500. Ahmadi, F., *et al.* Hysterosalpingographic Appearances of Female Genital Tract Tuberculosis: Part II: Uterus. *Int J Fertil Steril*, 2014. 8: 13.
<https://pubmed.ncbi.nlm.nih.gov/24696765>
501. Ahmadi, F., *et al.* Hysterosalpingographic appearances of female genital tract tuberculosis: part I. Fallopian tube. *Int J Fertil Steril*, 2014. 7: 245.
<https://pubmed.ncbi.nlm.nih.gov/24520493>

502. Netter, A., *et al.* [Tuberculous endo-uterine symphysis; an anatomic-clinical and radiologically characteristic syndrome]. *Gynecol Obstet (Paris)*, 1955. 54: 19.
<https://pubmed.ncbi.nlm.nih.gov/14391756>
503. 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>
504. European Centre for Disease Prevention 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>
505. 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://pubmed.ncbi.nlm.nih.gov/34654377>
506. Mittal, A., *et al.* Surgical Management of Genitourinary Tuberculosis: our Experience and review of literature. *Pol Przegl Chir*, 2020. 92: 1.
<https://pubmed.ncbi.nlm.nih.gov/33408264>
507. Figueiredo, A.A., *et al.* Epidemiology of urogenital tuberculosis worldwide. *Int J Urol*, 2008. 15: 827.
<https://pubmed.ncbi.nlm.nih.gov/18637157>
508. Mochalova, T.P., *et al.* Reconstructive surgery for treatment of urogenital tuberculosis: 30 years of observation. *World J Surg*, 1997. 21: 511.
<https://pubmed.ncbi.nlm.nih.gov/9204739>
509. Gupta, N.P., *et al.* Reconstructive surgery for the management of genitourinary tuberculosis: a single center experience. *J Urol*, 2006. 175: 2150.
<https://pubmed.ncbi.nlm.nih.gov/16697825>
510. 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://pubmed.ncbi.nlm.nih.gov/30803052>
511. 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://journals.indexcopernicus.com/api/file/viewByFileId/362945.pdf>
512. 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://pubmed.ncbi.nlm.nih.gov/30932738>
513. Zhang, S., *et al.* Open surgery versus retroperitoneal laparoscopic nephrectomy for renal tuberculosis: a retrospective study of 120 patients. *PeerJ*, 2016. 4: e2708.
<https://pubmed.ncbi.nlm.nih.gov/27917313>
514. Kim, H.H., *et al.* Laparoscopic nephrectomy for nonfunctioning tuberculous kidney. *J Endourol*, 2000. 14: 433.
<https://pubmed.ncbi.nlm.nih.gov/10958566>
515. 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://pubmed.ncbi.nlm.nih.gov/20110116>
516. Hemal, A.K., *et al.* Comparison of retroperitoneoscopic nephrectomy with open surgery for tuberculous nonfunctioning kidneys. *J Urol*, 2000. 164: 32.
<https://pubmed.ncbi.nlm.nih.gov/10840418>
517. 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>
518. Control, C.f.D. Procedure-associated Module 9: Surgical Site Infection (SSI) Event. . 2017.
<https://www.cdc.gov/nhsn/pdfs/pscmanual/9pscscscurrent.pdf>
519. Tanner, J., *et al.* Surgical hand antisepsis to reduce surgical site infection. *Cochrane Database Syst Rev*, 2016. 2016: CD004288.
<https://pubmed.ncbi.nlm.nih.gov/26799160>
520. Webster, J., *et al.* Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. *Cochrane Database Syst Rev*, 2015. 2015: CD004985.
<https://pubmed.ncbi.nlm.nih.gov/25927093>
521. Tanner, J., *et al.* Preoperative hair removal to reduce surgical site infection. *Cochrane Database Syst Rev*, 2011: CD004122.
<https://pubmed.ncbi.nlm.nih.gov/22071812>

522. 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://pubmed.ncbi.nlm.nih.gov/25881881>
523. Guenaga, K.F., *et al.* Mechanical bowel preparation for elective colorectal surgery. *Cochrane Database Syst Rev*, 2011. 2011: CD001544.
<https://pubmed.ncbi.nlm.nih.gov/21901677>
524. Dumville, J.C., *et al.* Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. *Cochrane Database Syst Rev*, 2015. 2015: CD003949.
<https://pubmed.ncbi.nlm.nih.gov/25897764>
525. Webster, J., *et al.* Use of plastic adhesive drapes during surgery for preventing surgical site infection. *Cochrane Database Syst Rev*, 2015. 2015: CD006353.
<https://pubmed.ncbi.nlm.nih.gov/25901509>
526. 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://pubmed.ncbi.nlm.nih.gov/29627196>
527. Control., E.C.f.D.P.a. Systematic review and evidence-based guidance on perioperative antibiotic prophylaxis. 2013.
<https://www.ecdc.europa.eu/sites/portal/files/media/en/publications/Publications/Perioperative%20antibiotic%20prophylaxis%20-%20June%202013.pdf>
528. Anonymous. Antibacterial prophylaxis in surgery: 2 - Urogenital, obstetric and gynaecological surgery. *Drug and Therapeutics Bulletin*, 2004. 42: 9.
<https://pubmed.ncbi.nlm.nih.gov/15067952>
529. Benseler, A., *et al.* Antibiotic prophylaxis for urodynamic testing in women: a systematic review. *Int Urogynecol J*, 2021. 32: 27.
<https://pubmed.ncbi.nlm.nih.gov/32845398>
530. 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>
531. 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://pubmed.ncbi.nlm.nih.gov/26138144>
532. 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://pubmed.ncbi.nlm.nih.gov/26200530>
533. Zeng, S., *et al.* Antimicrobial agents for preventing urinary tract infections in adults undergoing cystoscopy. *Cochrane Database Syst Rev*, 2019. 2: CD012305.
<https://pubmed.ncbi.nlm.nih.gov/30789676>
534. 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://pubmed.ncbi.nlm.nih.gov/33776335>
535. 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://pubmed.ncbi.nlm.nih.gov/22704118>
536. Mrkobrada, M., *et al.* CUA Guidelines on antibiotic prophylaxis for urologic procedures. *Can Urol Assoc J*, 2015. 9: 13.
<https://pubmed.ncbi.nlm.nih.gov/25737749>
537. 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://pubmed.ncbi.nlm.nih.gov/26910613>
538. 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://pubmed.ncbi.nlm.nih.gov/30197776>
539. 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://pubmed.ncbi.nlm.nih.gov/26377368>
540. Deng, T., *et al.* Antibiotic prophylaxis in ureteroscopic lithotripsy: a systematic review and meta-analysis of comparative studies. *BJU Int*, 2018. 122: 29.
<https://pubmed.ncbi.nlm.nih.gov/29232047>

541. Zhao, Z., *et al.* Recommended antibiotic prophylaxis regimen in retrograde intrarenal surgery: evidence from a randomised controlled trial. *BJU Int*, 2019. 124: 496.
<https://pubmed.ncbi.nlm.nih.gov/31136070>
542. 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://pubmed.ncbi.nlm.nih.gov/29290000>
543. 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://pubmed.ncbi.nlm.nih.gov/31562533>
544. Seyrek, M., *et al.* Perioperative prophylaxis for percutaneous nephrolithotomy: randomized study concerning the drug and dosage. *J Endourol*, 2012. 26: 1431.
<https://pubmed.ncbi.nlm.nih.gov/22612061>
545. Tuzel, E., *et al.* Prospective comparative study of two protocols of antibiotic prophylaxis in percutaneous nephrolithotomy. *J Endourol*, 2013. 27: 172.
<https://pubmed.ncbi.nlm.nih.gov/22908891>
546. 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://pubmed.ncbi.nlm.nih.gov/31011442>
547. 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.
<http://mji.ui.ac.id/journal/index.php/mji/article/view/3299/1579>
548. Dahm, P., *et al.* Evidence-based Urology. BMJ Books London, 2010: 50.
549. 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://pubmed.ncbi.nlm.nih.gov/33284673>
550. 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://pubmed.ncbi.nlm.nih.gov/29999216>
551. 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://pubmed.ncbi.nlm.nih.gov/31112286>
552. Crawford, D., *et al.* Infectious Outcomes from Renal Tumor Ablation: Prophylactic Antibiotics or Not? *Cardiovasc Intervent Radiol*, 2018. 41: 1573.
<https://pubmed.ncbi.nlm.nih.gov/30062444>
553. 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://pubmed.ncbi.nlm.nih.gov/33026903>
554. 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://pubmed.ncbi.nlm.nih.gov/35202507>
555. Bennett, H.Y., *et al.* The global burden of major infectious complications following prostate biopsy. *Epidemiol Infect*, 2016. 144: 1784.
<https://pubmed.ncbi.nlm.nih.gov/26645476>
556. Berry, B., *et al.* Comparison of complications after transrectal and transperineal prostate biopsy: a national population-based study. *BJU Int*, 2020. 126: 97.
<https://pubmed.ncbi.nlm.nih.gov/32124525>
557. Castellani, D., *et al.* Infection Rate after Transperineal Prostate Biopsy with and without Prophylactic Antibiotics: Results from a Systematic Review and Meta-Analysis of Comparative Studies. *J Urol*, 2022. 207: 25.
<https://pubmed.ncbi.nlm.nih.gov/34555932>
558. 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://pubmed.ncbi.nlm.nih.gov/35243391>
559. Chernysheva, D.Y., *et al.* The first experience of transperineal prostate biopsy without antibiotic prophylaxis. *Cancer Urology*, 2021. 17: 46.
https://oncurology.abvpress.ru/oncur/article/view/1392?locale=en_US
560. 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://pubmed.ncbi.nlm.nih.gov/35839791>

561. 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/113/Supplement_1/hcaa070.024/5829649?login=false
562. 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://pubmed.ncbi.nlm.nih.gov/31922485>
563. 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>
564. 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 DOI: <http://dx.doi.org/10.1016/S0090-4295%2814%2901020-6>.
565. 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://pubmed.ncbi.nlm.nih.gov/24762693>
566. 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://pubmed.ncbi.nlm.nih.gov/32913154>
567. 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://pubmed.ncbi.nlm.nih.gov/36910899>
568. Russo, F., *et al.* MR-TARGETED VS. TRUS-GUIDED PROSTATE BIOPSY IN PATIENTS WITH HIGH PSA VALUES: A RANDOMIZED CONTROLLED TRIAL. Anticancer Research, 2016. 36: 2556.
<https://ar.iiarjournals.org/content/anticanres/36/5/2535.full.pdf>
569. 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://pubmed.ncbi.nlm.nih.gov/32105195>
570. 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.
571. Andreasson, A., *et al.* Fosfomycin versus Ciprofloxacin as transrectal prostatebiopsy antibiotic prophylaxis – an open randomized controlled multicenter drug trial. European Urology, 2023. 83: S180.
<https://www.sciencedirect.com/science/article/pii/S0302283823001835>
572. 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://pubmed.ncbi.nlm.nih.gov/30553114>
573. 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://pubmed.ncbi.nlm.nih.gov/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 is publicly accessible through the EAU website: <http://www.uroweb.org/guidelines/>. 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.

6. CITATION INFORMATION

The format in which to cite the EAU Guidelines will vary depending on the style guide of the journal in which the citation appears. Accordingly, the number of authors or whether, for instance, to include the publisher, location, or an ISBN number may vary.

The compilation of the complete Guidelines should be referenced as:

EAU Guidelines. Edn. presented at the EAU Annual Congress Paris 2024. ISBN 978-94-92671-23-3.

If a publisher and/or location is required, include:

EAU Guidelines Office, Arnhem, The Netherlands. <http://uroweb.org/guidelines/compilations-of-all-guidelines/>

References to individual guidelines should be structured in the following way:

Contributors' names. Title of resource. Publication type. ISBN. Publisher and publisher location, year.