Urinary Tract Infections (UTIs)

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Last Update: January 26, 2021

Terminology and Classification Schemes

Cystitis: symptomatic infection of the bladder (lower tract)
Pyelonephritis: symptomatic infection of the kidneys (upper tract)
Uncomplicated UTI: acute cystitis in non-pregnant, premenopausal females without structural or functional GU abnormalities
Complicated UTI: everything else
Recurrent UTI: >2 UTIs within 6 months or >3 UTIs within a year

- Relapse: reoccurrence within two weeks with same organism raising question of potential abscess or stone
- Reinfection: infection with different organism

Asymptomatic bacteriuria (ASB): bacteria usually with WBCs but no clinical symptoms
Catheter-associated bacteriuria: symptomatic catheter-associated UTI (CAUTI) or asymptomatic
Prostatitis: prostate infection

Epidemiology and Risk Factors

Incidence

UTIs
Overall, much more common in females than males
Neonatal period: male infants slightly higher than female infants because of congenital urinary tract anomalies
Age 1 year to ~ 50 years of age: predominantly females
Age > 50 years of age: men almost as high as females because of prostatic hypertrophy
ASB
Women between age 20 and 40: 5%
Elderly women and men: 40-50%
Lifetime incidence
50-80% of women acquire at least one UTI
Recurrent UTIs
20-30% of women who have had one UTI will have recurrent episodes
For women who have recurrences, rate of recurrence 0.3 to 7.6 infections /patient /year with average 2.6 infections /year
CAUTI
Bacteriuria: 3-20% per day of catheterization
Infection: 10-25% of those who are bacteriuric
Prostatitis
Both infectious and noninfectious causes
Prostate inflammation which can be either acute or chronic
Chronic pelvic pain syndrome is now the term for chronic noninfectious prostatitis
Acute bacterial less common than chronic bacterial prostatitis

Host Risk Factors for UTIs

Genitalia

- Short urethra in females
- Urethral trauma with sexual intercourse
- Uncircumcised male

Obstructive impaired emptying

- Congenital urethral valves in male infants
- BPH in men
- Strictures of the urethra or ureter
- Stones
- Tumors

Functional impaired emptying
- Pregnancy (decreased ureteral peristalsis and tone)
- Neurogenic bladder

Urologic
- Catheters
- Stents
- Cystoscopy
- Renal transplant

Genetic
- Maternal history of UTIs

Chemical and Metabolic
- Nonoxynol-9 contraceptive jelly
- Spermicides (increase bacterial adherence to vaginal epithelial cells)
- Diabetes: 2-3 x higher incidence of UTIs and ASB in women
- Post-menopausal estrogen deficiency (change in vaginal lactobacilli causing loss of protective effect)

Host Risk Factors for Recurrent UTIs

Clustering of recurrences may be related to:
- Presence of new risk factor
- Sloughing of outer bladder epithelial layer
- Antibiotic alteration of normal flora

Predisposing factors for premenopausal females
- Frequent sexual intercourse
- New sexual partner
- Use of spermicide
- First UTI before age 15
- Maternal history of UTIs

Predisposing factors for postmenopausal females
- History of premenopausal UTIs
- Impaired bladder emptying
- Urinary incontinence

CAUTI Risk Factors

Duration of catheterization is the most important risk factor
Female
Older age
Diabetes mellitus
Errors in catheter care

Microbiology

Etiology

Cystitis and Pyelonephritis

Organism	Percentage
Escherichia coli	75-90%
Staphylococcus saprophyticus	5-15% (younger women)
Klebsiella, Proteus, Enterococcus, Citrobacter	5-10%

CAUTI

Organism	Percentage
Escherichia coli	24%
Candida	24%
Enterococcus	14%
Pseudomonas aeruginosa	10%
Klebsiella	10%
Proteus, Citrobacter, Acinetobacter, Morganella, Staphylococcus	

Prostatitis

Escherichia coli in ~80% of cases
Klebsiella, Enterobacter, Pseudomonas, Enterococci next most frequent
Staphylococci rarely and if *S. aureus*, be concerned about seeding from bacteremia

Acute cystitis antimicrobial resistance patterns in many U.S. regions

TMP-SMX >20%
Ciprofloxacin >10%

Important to know your local patterns when choosing empiric regimens

Bacterial Virulence Factors

Escherichia coli

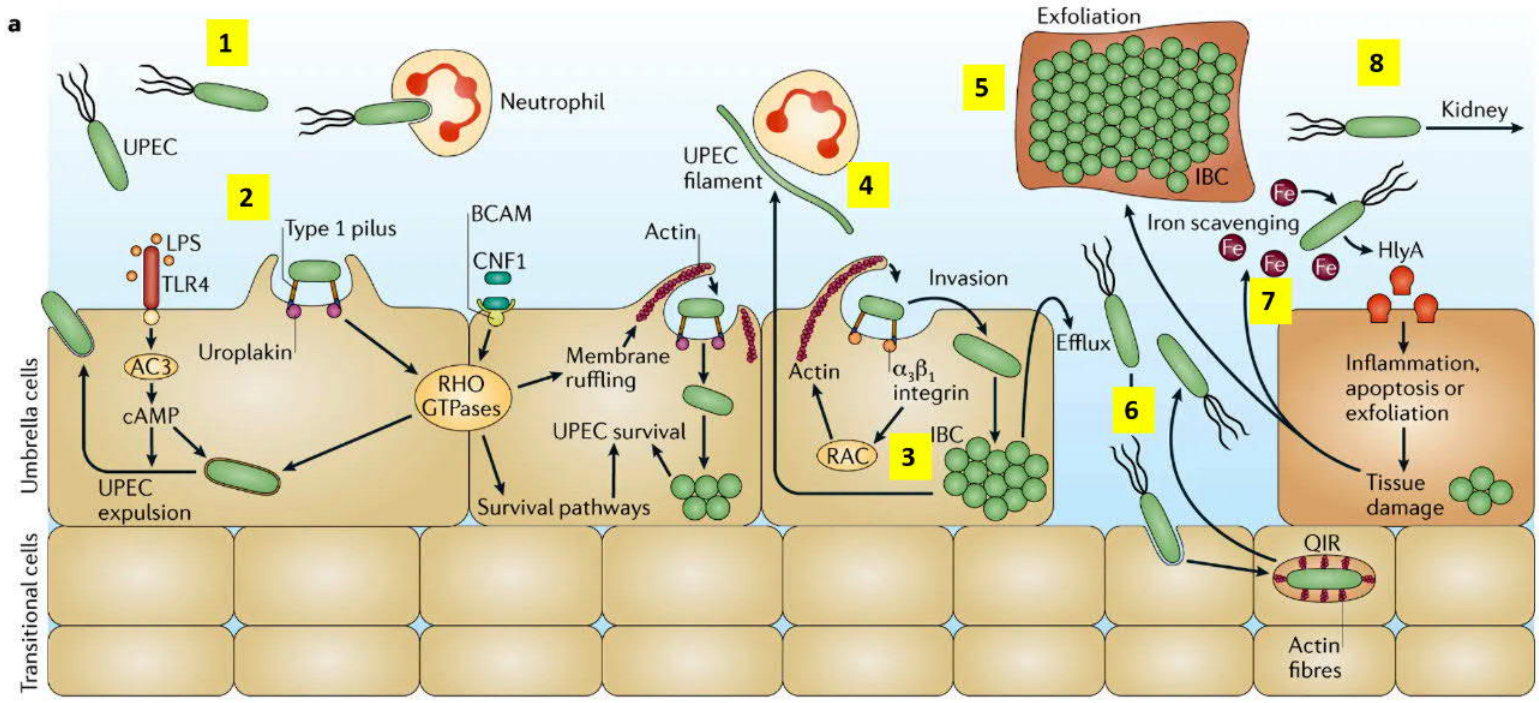
Gram-negative bacillus; member of the Enterobacteriaceae

Certain strains of *E. coli* (uropathogenic *E. coli* or UPEC) are selected from the fecal microbiota by the presence of virulence factors that enhance both colonization and invasion of the urinary tract

Virulence factors

- Type 1 fimbriae (pili): Tips attach to mannose moieties of membrane proteins (uroplakins) → periurethral and bladder transitional epithelial cell colonization
- P fimbriae (pili): Tips attach to Gal-Gal globoside (glycosphingolipid with more than one sugar side chain) receptors in renal pelvis and kidney
- Flagella driven motility
- Operons that reciprocally regulate expression of flagella affecting adhesion vs. motility
- After adhesion, invasion and replication within host epithelial cells forming intracellular bacterial communities (IBCs) that act to protect from host defenses and antimicrobials
- α-hemolysin, cytotoxic necrotizing factor 1 (CNF1) toxins cause cell injury and death
    - Hemolysin punches pores in cell membranes facilitating bacterial entry into tissues
    - Fe released by host cell injury is scavenged by bacterial siderophores
- Enterobactin, aerobactin (bacterial siderophores = iron-scavenging proteins)
    - Iron (Fe) is an important nutrient for bacterial growth but the bladder environment is iron poor
    - Fe is bound to heme proteins (hemoglobin, myoglobin) and iron-chelating proteins (transferrin, lactoferrin)
    - These siderophores that compete for Fe are more frequently found in UPEC strains
- LPS (lipopolysaccharide) endotoxin

Role of Virulence Factors in UPEC Cystitis



Flores-Mireles et al. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. Nat Rev Microbiol. 2015 May;13(5):269–84.

1. Flagella provides motility
2. Type 1 pili or fimbriae attach to uroplakins (mannose moieties on bladder umbrella cells)
3. Invasion and formation of IBCs (Intracellular Bacterial Colonies act as an "internal biofilm")
4. Filament formation → invasion of adjacent umbrella cells
5. Exfoliation of umbrella cells
6. Reciprocal regulation between adhesive and motile forms
7. Scavenging of needed iron from lysed bladder cells
8. Swim upstream to the kidney

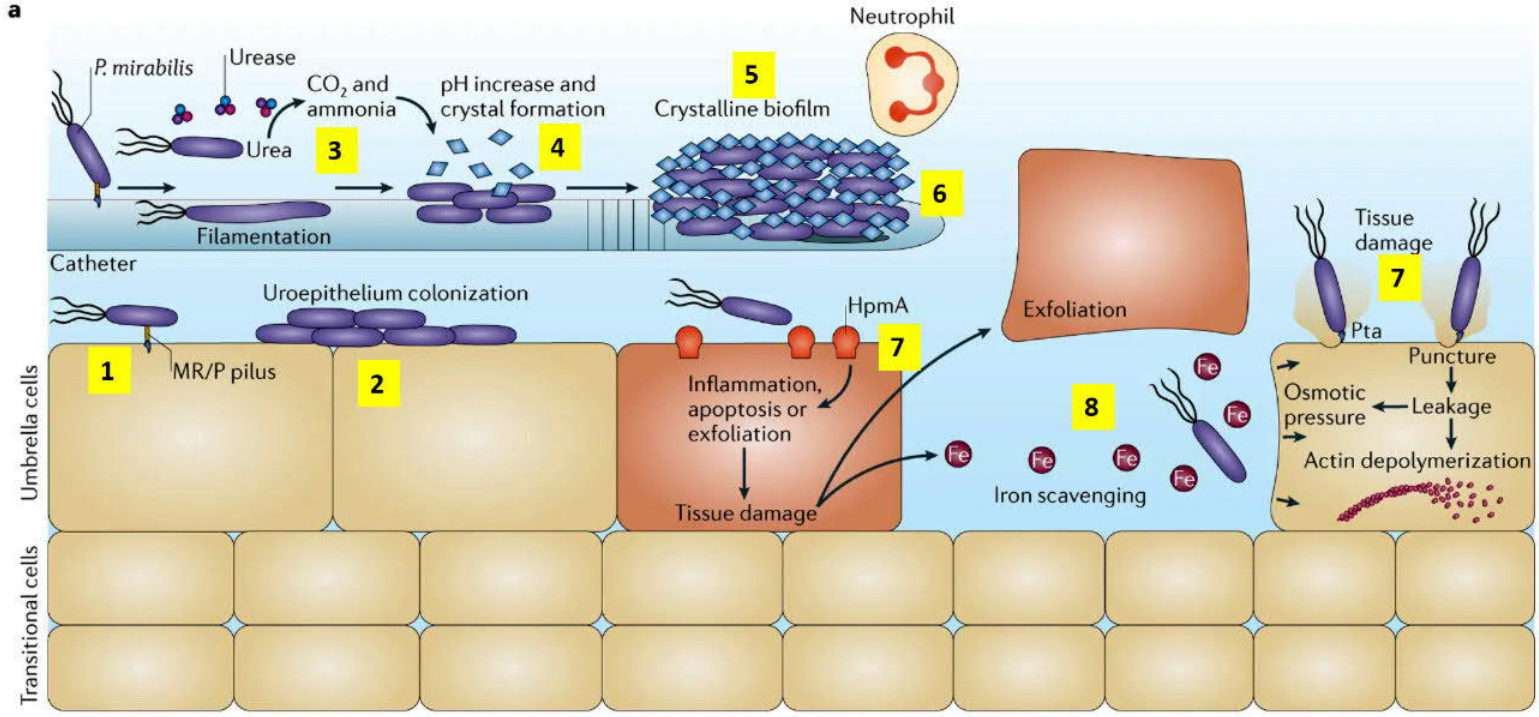
Proteus mirabilis

Gram-negative bacillus; member of the Enterobacteriaceae

Virulence factors

- Multiple adhesion proteins
- Large numbers of fimbriae and flagella promote motility (aggregate "swarming" motility seen on culture plates)
- Reciprocal regulation of adhesion and motility
- Potent urease production
    - Hydrolyzes urea to CO_2 and ammonia → alkalinizes urine → absence of acidity promotes bacterial growth
    - Precipitation of struvite (magnesium ammonium phosphate) crystals → stones (with potential obstruction)
    - Hiding in the interstices of stones allows bacteria to persist despite antibiotics
    - pH > 7 suggests infection with urease-positive bacteria

Role of Virulence Factors in *Proteus mirabilis* CAUTI



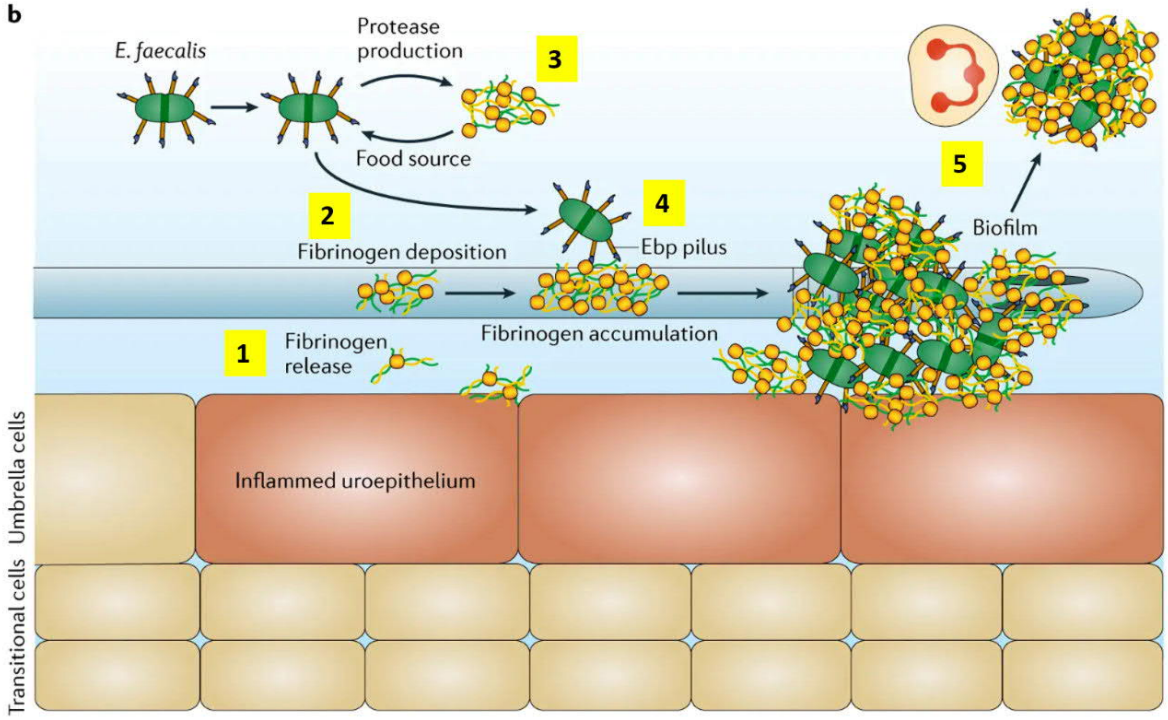
Flores-Mireles et al. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. Nat Rev Microbiol. 2015 May;13(5):269–84.

1. Mannose-resistant Proteus-like (MR/P) pili for initial attachment
2. Biofilm formation on the catheter and in the bladder.
3. Urease hydrolyzes urea to CO2 and NH3 with subsequent pH increase
4. Induces formation of calcium crystals (apatite) and magnesium ammonium phosphate (struvite) precipitates
5. Crystalline biofilm on catheter and on cells protects from the host immune system and antibiotics
6. Crystalline biofilm also prevents proper urine drainage promoting progression to pyelonephritis and bacteremia
7. Bacterial toxins hemolysin (HpmA) and Proteus toxic agglutinin (Pta) involved in tissue destruction and bacterial dissemination
8. Release of nutrients via these toxins also allows bacterial siderophores to scavenge iron

Enterococcus

Gram-positive coccus

Role of Virulence Factors in *Enterococcus faecalis* CAUTI



Flores-Mireles et al. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. Nat Rev Microbiol. 2015 May;13(5):269–84.

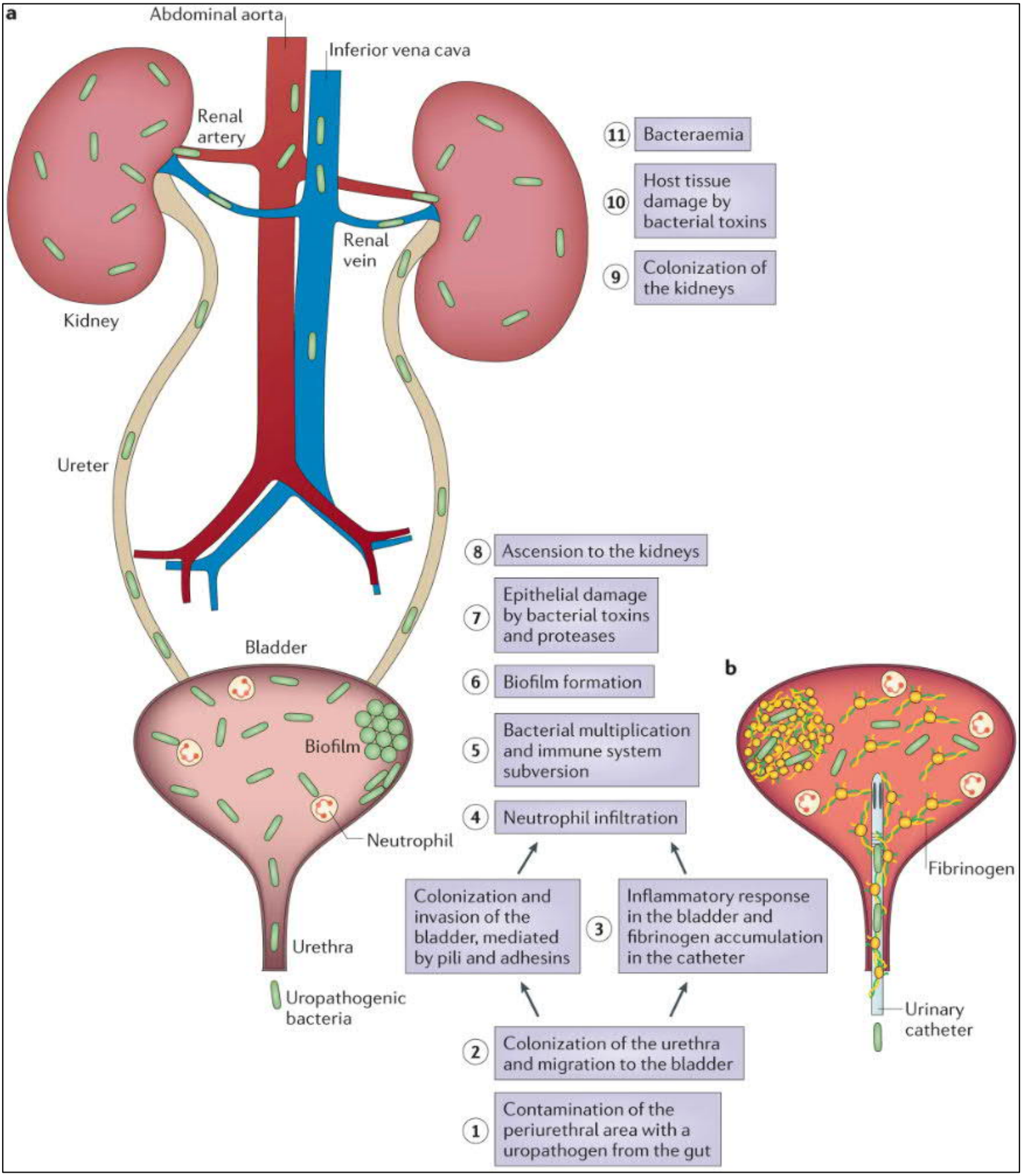
1. Catheter implantation causes bladder inflammation which results in fibrinogen release
2. Fibrinogen deposits and accumulates on catheter
3. *E. faecalis* uses fibrinogen as a food source through the production of proteases
4. *E. faecalis* binds fibrinogen through the endocarditis- and biofilm-associated (Ebp) pilus forming biofilm
5. Biofilm protects bacteria from host immune system

Staphylococcus saprophyticus

Gram-positive, coagulase negative Staphylococcus that colonizes rectum or urogenital tract in 5-10% of women
Unlike for Enterobacteriaceae, the urine nitrite test is negative.
Resistant to novobiocin seen as growth right up to disk margin on culture plate.
Cause of cystitis in young, sexually active women
Often follows intercourse or menstruation
May occur concomitantly with vaginal candidiasis
Seasonal predilection (late summer and fall)
Virulence factors

- Adhesion protein (UafA) → adherence to uroepithelial cells
- Transport proteins allow rapid adjustment to urinary osmotic and pH changes
- Urease production facilitates growth in urine

Pathogenesis



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General

Introduction of bacteria into bladder does not inevitably result in UTI

- Normal voiding can excrete the bacteria before they become established
- Innate host defenses can kill the bacteria before they become established

Put simply, anything that increases bacteria entering the bladder AND staying there, increases risk of UTI

Ascending Route

Majority of UTIs via the ascending route
Ultimate source of UPEC and other uropathogens is the intestinal tract
In women, the next phase is colonization of the vaginal introitus and periurethral meatus
    Colonization occurs in in parallel with concomitant loss of protective lactobacilli
    Lactobacilli decrease pH, interfere with uropathogen adherence to vaginal epithelial cells, produce bacteriocins and H_2O_2
Short urethra in women

Hematogenous Route

Accounts for less than 2% of UTIs
Staphylococcus aureus or *Salmonella* UTI requires search for an originating source outside the GU system

CAUTI

Entry most commonly along biofilm that forms around catheter in the urethra (66%)
Can also occur via ascension through the lumen of catheter from contaminated catheter drainage bag (34%)
For older patients, only finding might be change in mental status

Clinical Presentation

Cystitis

Typical symptoms: dysuria, frequency, urgency
Other symptoms: nocturia, hesitancy, suprapubic discomfort, hematuria

Pyelonephritis

Mild: low-grade fever, +/- costovertebral tenderness (CVAT)
Severe: high-grade fevers, rigors, nausea, vomiting, flank pain and CVAT
May take at least 3 days for fevers to resolve after initiation of antimicrobials

CAUTI

Fever is most common symptom
May or may not have localizing symptoms referable to urinary tract
Pyuria is usually present

Prostatitis

Acute bacterial prostatitis

- Acute illness with fevers, chills, dysuria, frequency, and pain in the prostatic pelvic or perineal area
- Symptoms of bladder outlet obstruction

Chronic bacterial prostatitis

- More insidious onset
- Recurrent episodes of cystitis
- Sometimes perineal or pelvic pain

Complications

Cystitis

Emphysematous cystitis in diabetic patients typically caused by gas-forming *E. coli*

Pyelonephritis

Bacteremia in 20-30% of severe cases
Renal and perinephric abscess

- Delay in response to antibiotics or bacteremia should raise concern about these possibilities

Acute papillary necrosis in diabetic patients results in obstructive uropathy
Emphysematous pyelonephritis in diabetic patients typically caused by gas-forming *E. coli*
Xanthogranulomatous pyelonephritis

- Following chronic obstruction often by staghorn calculus

- Enlargement and destruction of kidney
- Mass effect can mimic a malignancy

Asymptomatic Bacteriuria in Pregnancy

Associated with development of maternal pyelonephritis
Pyelonephritis can cause pre-term delivery

CAUTI

Sepsis, bacteremia
Purple urine – not a complication but an unusual presentation

- Biochemical reaction if certain bacteria present in alkaline urine (*Proteus, Providencia, Klebsiella*, or *Pseudomonas*)
- Dietary tryptophan converted to indole by intestinal flora
- Metabolized by liver to indoxyl sulfate
- Converted by urinary bacterial enzyme (indoxyl sulfatase and indoxyl phosphatase) to indigo (blue) + indirubin (red)
- Two pigments combine to cause purple urine

Prostatitis

Prostate abscess
Sepsis, bacteremia
Emphysematous prostatitis (mainly in patients with diabetes)

Diagnosis

History in Women

One of the following symptoms (dysuria, frequency, hematuria or back pain): probability of UTI is 50%
Dysuria + frequency AND no vaginal symptoms: probability of UTI is 96%
STIs always a concern with young women presenting with dysuria

- Cervicitis due to *C. trachomatis, Neisseria gonorrhoeae*
- Vaginitis due to *Candida albicans, Trichomonas vaginalis*

Laboratory Studies

Urine Dipstick

Urine nitrite
Only Enterobacteriaceae convert nitrate to nitrite
Enough nitrite must accumulate in urine to reach detection threshold
If urine dilute, nitrite test will be negative
False negatives with $\leq 10^2$ - 10^3 bacteria/ml

Leukocyte esterase (LE)
Detects enzyme from intact or lysed PMNs
Largely replaced microscopic method
Detects > 10 WBC/mm^3 (mm^3 = µl)
Sensitivity 75-96%, Specificity 94-98%

Urinalysis and Microscopy

Most hospital laboratories now use an automated approach to microscopy
Pyuria

- Definition: >10 WBC/mm^3 in unspun urine
- Nearly all cases of cystitis have pyuria

Hematuria found in ~30% of cases

Urine Gram Stain and Culture

Gram stain
In serious cases where time matters, I recommend Gram stain of unspun urine

- Quick general categorization of pending culture i.e. gram-negative or gram-positive bacteria
- 1 organism seen per oil immersion high power field (1 org /hpf) correlates with > 10^5 bacterial / ml

Obtaining Samples for Culture

Techniques

- Clean cut midstream urine (most common)
- In and out catheter
- Suprapubic puncture
- Catheter port for CAUTI (*never sample from the catheter bag itself*)

Get the sample to the lab ASAP to prevent overgrowth at room temperature creating higher CFU counts

Quantitative Urine Cultures

CATEGORY	QUANTITATIVE BACTERIAL COUNT
Asymptomatic bacteriuria	$\geq 10^5$ CFU/mL in two consecutive specimens for women
Acute uncomplicated cystitis	$\geq 10^2$ CFU/mL of *Escherichia coli* or *Staphylococcus saprophyticus*
Acute uncomplicated pyelonephritis	$\geq 10^4$ CFU/mL (95% have $\geq 10^5$ CFU/mL)
Complicated urinary tract infection	$\geq 10^5$ CFU/mL (lower counts may occur with diuresis)
Intermittent or in and out catheter	$\geq 10^2$ CFU/mL
Suprapubic or percutaneous aspiration	Any organisms isolated

Table 268-4. Nicolle LE, Drekonia D. Approach to the Patient with Urinary Tract Infection. In: Goldman L, Schafer AI, eds. Goldman-Cecil Medicine. 26th ed. Philadelphia, PA: Elsevier; 2020.

Diagnostic Approach to Use of Lab Studies

Uncomplicated Cystitis in Nonpregnant Women

Urine Dipstick

While some recommend treating based on history alone, I don't

At a minimum, I suggest a urine dipstick

One cystitis symptom + either dipstick positive nitrite or LE: probability of UTI increase from 50% to 80%

Both negative dipstick nitrite and LE: strongly predictive that UTI does not exist

Urine Gram Stain and Culture

Any question of complication

Any discordant finding between urinalysis and patient's symptoms and signs

Complicated UTI

Urine dipstick

Urinalysis and microscopy

- WBC casts on microscopy are strong evidence of pyelonephritis
- Absence of WBC casts does not exclude pyelonephritis

Urine Gram stain and culture

Prostatitis

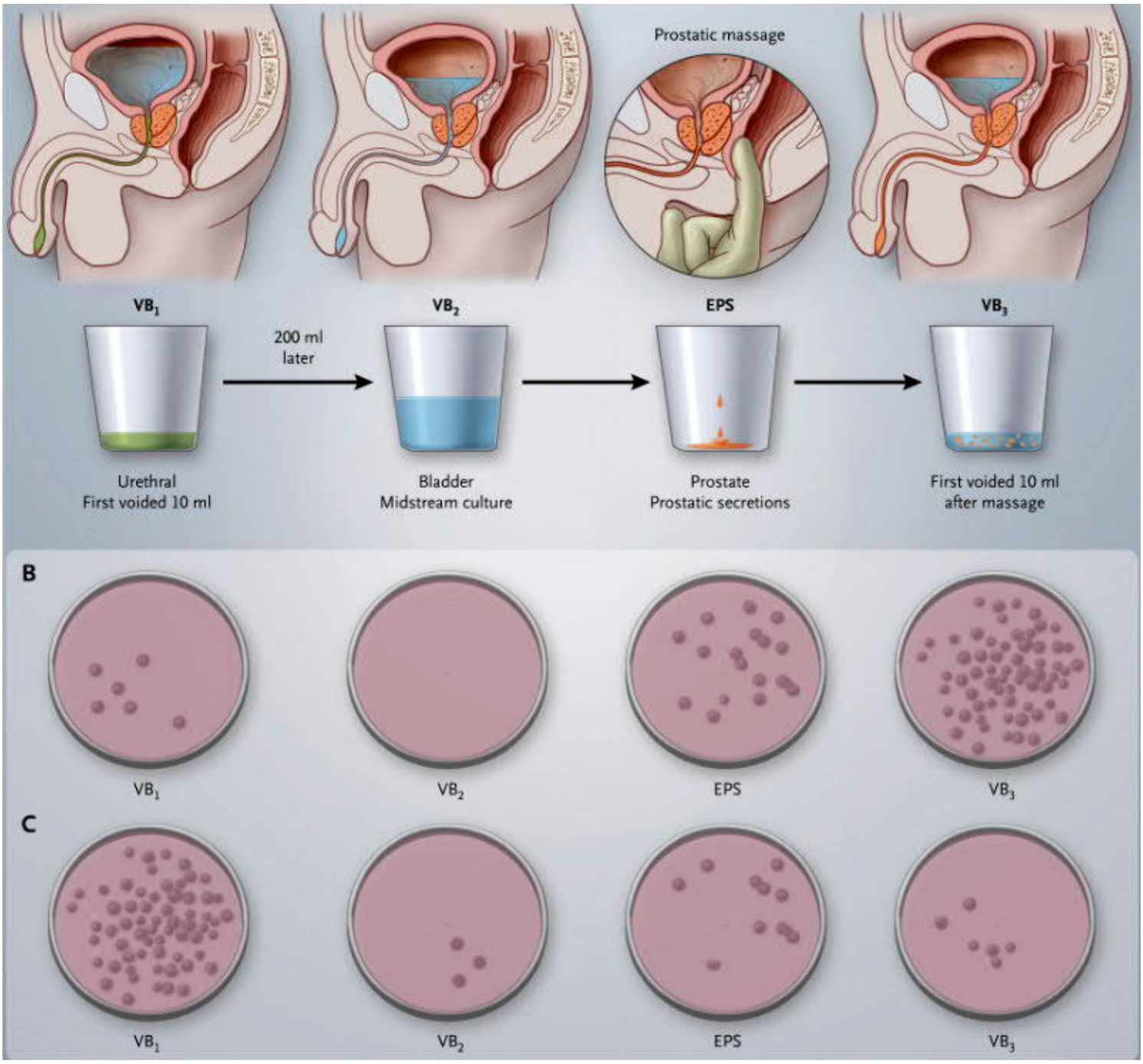
First febrile UTIs

- Prostate specific antigen (PSA) often elevated
- Urine for culture and sensitivity
- Consider Urology consult

Recurrent UTIs

- CT scan or ultrasound
- 4-glass Meares-Stamey test (urine collection for C&S after prostate massage)
- NEVER perform prostate massage if patient febrile with acute prostatitis; may induce bacteremia

The 4-Glass Meares-Stamey Test



Schaeffer AJ, Nicolle LE. Urinary tract infections in older men. Solomon CG, editor. N Engl J Med. 2016 Feb 11;374(6):562-71.

Collection

1. Patient voids the first 10 ml of urine (the urethral specimen VB1) into a collection glass.
2. After the patient voids approximately 200 ml, a midstream specimen (bladder urine VB2) is collected.
3. After the bladder is emptied, expressed prostatic secretions (EPS) are obtained after prostatic massage.
4. First 10 ml of urine that is voided after prostatic massage (VB3) is prostatic washout.

Interpretation

- Prostatitis (Panel B): Presence of bacteria in the EPS and VB3 samples when the VB1 and VB2 samples do not show growth (or a CFU/ml count 10 times higher in the EPS and VB3 samples as in the VB1 and VB2 samples).
- Urethral colonization (Panel C): Growth of gram-negative bacilli in the VB1 specimen without substantial growth in the other samples.
- Gram-positive staphylococcal species frequently colonize the distal urethra and do not cause bacterial prostatitis.

Treatment

General Considerations

1. Know local antimicrobial resistance rates when deciding on empiric therapy
   Link to WA State Department of Health Antibiograms
   https://www.doh.wa.gov/ForPublicHealthandHealthcareProviders/HealthcareProfessionsandFacilities/HealthcareAssociatedInfections/AntibioticResistance/Stewardship/Antibiograms
2. Also know if the patient might have an increased risk of drug-resistant organisms
   - Recent inpatient stay
   - Prior history of urinary multidrug resistant (MDR) organism
   - Recent antimicrobial use
   - Travel to countries with high MDR patterns
3. If cultures obtained, culture and sensitivity results guide therapy

Mechanisms of Action of Selected Antimicrobials

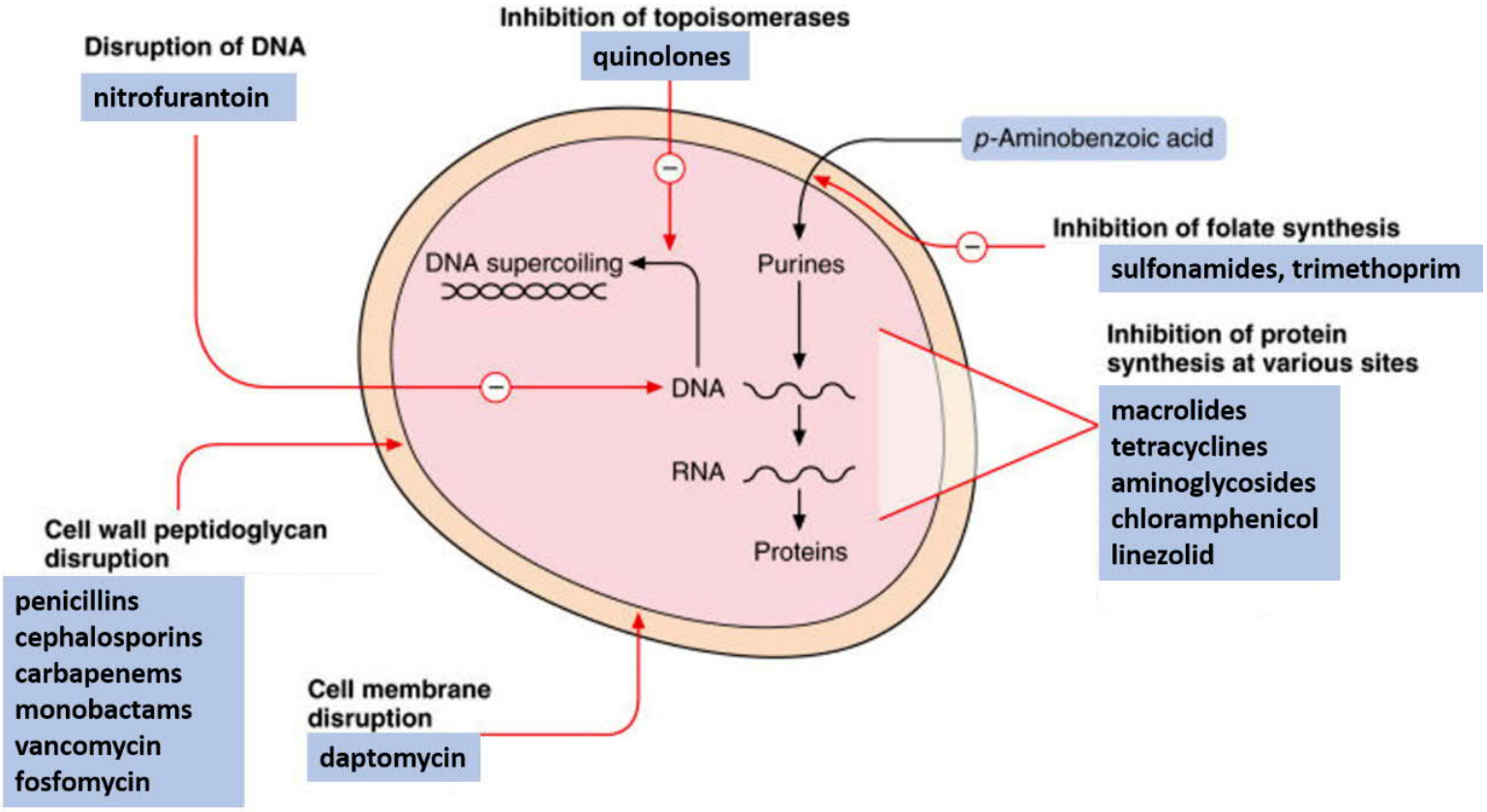


Fig 51.1. Waller DG, Sampson AP, eds. Medical Pharmacology and Therapeutics, 5th ed. Philadelphia, PA: Elsevier; 2018

Cystitis

ANTIMICROBIAL	DOSE AND DURATION
First-Line Therapy	
Nitrofurantoin macrocrystals	100 mg PO bid x 5 days
Trimethoprim-sulfamethoxazole (TMP-SMX)	160/800 mg PO q12 x 3 days
Fosfomycin trometamol	3 g PO single dose
Trimethoprim	100-150 mg PO q12h x 3 days
Second-Line Therapy	
Amoxicillin-clavulanate	500 mg (amoxicillin dose) PO q8h x 7 days
Cefaclor	250 mg PO tid x 5 days
Cefdinir	100 mg PO bid x 5 days
Cefpodoxime proxetil	100 mg PO bid x 3 days
Third-Line Therapy	
Ciprofloxacin	250 mg PO q12h x 3 days (500 mg qd extended release)
Levofloxacin	250-500 PO mg/day x 3 days

Because of inferior efficacy and higher incidence of adverse events, β-lactams should be considered only if nitrofurantoin, TMP-SMX, and fosfomycin cannot be used, with fluoroquinolones reserved as the last resort for therapy.
The FDA advises that the side effects of fluoroquinolones outweigh their benefits when patients with acute uncomplicated urinary tract infections have other options.

Pyelonephritis (If Patient Requires Hospitalization)

See Provisos at start of Treatment section

Indications for Hospitalization

- General indications
  - Persistently high fever (>101°F/>38.4°C) or pain
  - Marked debility
  - Inability to maintain oral hydration or take oral medications
  - Suspected urinary tract obstruction or complications
  - Concerns regarding adherence to therapy
- Critical illness or sepsis

ANTIMICROBIAL	DOSE AND DURATION
Ciprofloxacin	400 mg IV q12h × 7 days
Levofloxacin	750 mg/day IV × 5 days
Ceftriaxone	1-2 g qd IV × 10-14 days
Piperacillin-tazobactam	3.375 - 4.5g IV q6h × 10-14 days
Imipenem	500 mg IV q6h x 10-14 days
Meropenem	1 gm IV q8h × 10-14 days
Doripenem	500 mg IV q8h × 10-14 days
Ertapenem	1 g IV qd × 10-14 days
Gentamicin	4.5 mg/kg/day IV × 10-14 days
Tobramycin	4.5 mg/kg/day IV × 10-14 days
GPCs on Gram stain, add one of the following:	
Vancomycin	15 mg/kg IV q12h x 10-14 days
Daptomycin	6 mg/kg IV q24h x 10-14 days
Linezolid	600 mg IV q12h x 10-14 days

Pyelonephritis (If Patient Does Not Require Hospitalization)

ANTIMICROBIAL	DOSE AND DURATION
Ciprofloxacin	500 mg q12h PO × 7 days with or without an initial 400 mg IV dose
Levofloxacin	250-500 mg/day PO × 5-7 days with or without initial 750 mg IV dose
Trimethoprim-sulfamethoxazole (TMP-SMX)	160/800 mg PO q12 x 14 days if uropathogen susceptible with initial 1 gm IV ceftriaxone if uropathogen susceptibility unknown

Pregnancy

Ampicillin and the cephalosporins are the drugs of choice for the treatment of asymptomatic or symptomatic UTI
Treat for 4-7 days
Nitrofurantoin, ampicillin, and the cephalosporins are considered relatively safe in early pregnancy
Avoid sulfonamides in the first trimester because of possible teratogenic effects
Avoid sulfonamides near term because of possible role in the development of kernicterus
Avoid fluoroquinolones because of possible adverse effects on fetal cartilage development
Parenteral β-lactam therapy with or without aminoglycosides is the standard of care for pyelonephritis

Prostatitis

Goal is to eradicate the prostatic infection as well as the bladder infection
Urine culture results guide therapy with fluoroquinolone or TMP-SMX as empiric therapy pending results

- Acute bacterial prostatitis treated for 2 -4 weeks
- Chronic bacterial prostatitis treated for 4- to 6-weeks
- Recurrences treated for 12-weeks

Asymptomatic Bacteriuria

Who to treat?

- Pregnant women (guided by culture results)
- Patients undergoing urologic procedures (guided by culture results)
- Neutropenic patients (perhaps)
- Renal transplant recipients (perhaps)

Pediatrics

- Avoid fluroquinolones if possible, because of risk of cartilage injury
- Dosage based on body weight
- Culture results guide continued therapy

Cystitis

- Mild symptoms or diagnosis doubtful, can delay therapy pending culture results
- TMP-SMX 6-12 mg TMP/kg/day PO in 2 divided doses x 3-5 days
- TMP 6-12 mg TMP/kg/day PO in 2 divided doses x 3-5 days
- Nitrofurantoin 5-7 mg/kg /day PO in 3-4 divided doses x 3-5 days

Pyelonephritis

- Dehydration, vomiting, unable to take PO fluids, complications or sepsis warrant hospitalization and IV therapy
- Ceftriaxone 50mg/kg/day IV (not to exceed 2gm per day) x 10-14 days
- Cefepime 100 mg/kg/day IV q12h x 10-14 days
- Cefotaxime 100-150 mg/kg/day IV in 3-4 divided doses x 10-14 days

CAUTI

Urine culture essential to guide therapy
Catheter removal and change to remove biofilm coated catheter

Candiduria

Removal of catheter alone results in resolution of 1/3 of asymptomatic cases
Asymptomatic cases that require treatment are those at high risk for dissemination

- Neutropenia
- Planned urologic manipulation
- Clinically unstable
- Low-birth-weight infants

Symptomatic cystitis and pyelonephritis require treatment
Regimens

- Fluconazole 200-400 mg/d PO x 7-14 days
- Oral flucytosine or amphotericin if resistant to fluconazole

Prevention

Recurrent UTIs in Women

Antibiotic-sparing strategies first

Contraception modification i.e. cessation of spermicides
Perineal hygiene -wiping from front to back
Vaginal estrogens for postmenopausal women

Antibiotic strategies

Need to know previous culture results to modify recommended antibiotics

3 prophylactic strategies: continuous, postcoital, and patient-initiated with TMP-SMX, nitrofurantoin being likely choices

- Continuous prophylaxis if episodes temporally unrelated to sexual intercourse
- Postcoital prophylaxis if episodes temporally related to sexual intercourse
- Patient-initiated prophylaxis: at first symptoms but urine culture refrigerated and brought to clinic ASAP

Effective while regimen in place

Usually prescribed for 6 months with recurrence rates returning to baseline after cessation

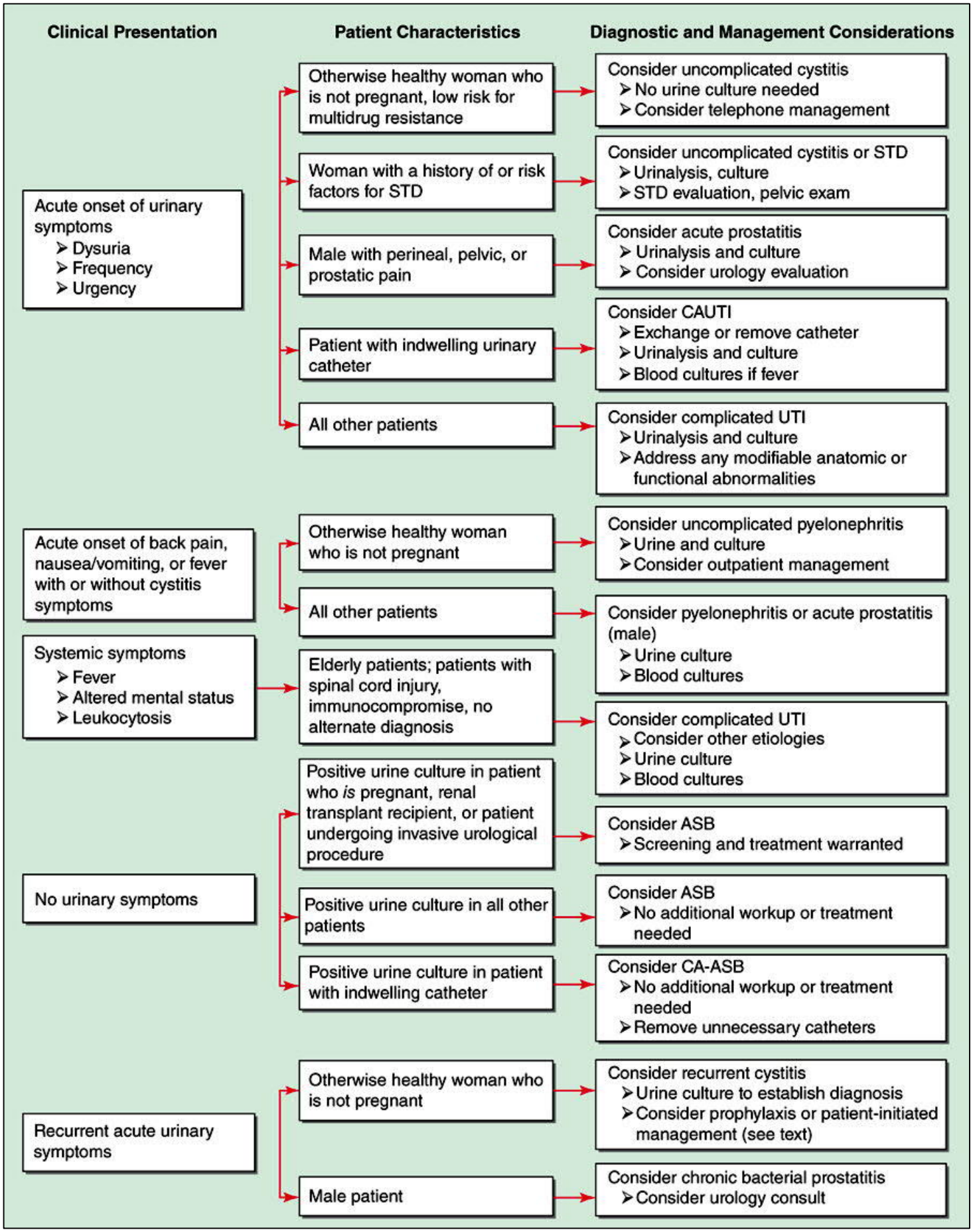
CAUTI

Avoid inserting in first place if possible

Remove unnecessary catheter once no longer needed

Intermittent catheterization preferable to long-term indwelling catheter i.e. spinal cord-injured patients

Summary of Approach to UTIs



Gupta K, Trautner BW. Chapter 130: Urinary Tract Infections, Pyelonephritis, and Prostatitis. In: Jameson JL, Fauci AS, Kasper DL, Hauser SL, Longo DL, Loscalzo J, eds. Harrison's Principles of Internal Medicine. 20th ed. New York, NY: McGraw-Hill; 2018.