

Urinary Tract Infections

- Symptomatic and asymptomatic UTI's are a common problem
- > 10 million office visits per year
- > 1 million hospital admissions per year
- Cause of significant nosocomial morbidity
- Affects women more than men throughout life

UTI's in Adults

- Acute uncomplicated UTI in young women
- Acute uncomplicated pyelonephritis
- Recurrent UTI's in women
- Complicated UTI's in older women
- Catheter-associated bacteriuria
- Asymptomatic bacteriuria
- Candiduria

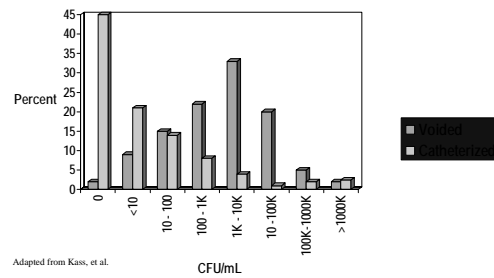
UTI - Definitions

- | | |
|--------------------|-----------------------|
| • Lower UTI | • Upper UTI |
| – cystitis | – pyelonephritis |
| – urethritis | – intra-renal abscess |
| – prostatitis | – perinephric abscess |

- **Uncomplicated:** simple cystitis of short (1-5 days) duration
- **Complicated:** long-duration or hemorrhagic cystitis, cystitis with anatomic or functional abnormalities, cystitis with progression to involve the upper tract, or instrumentation-related cystitis

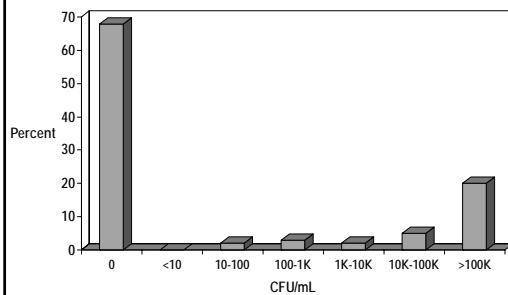
Asymptomatic Women

Voided vs. Catheterized Specimen

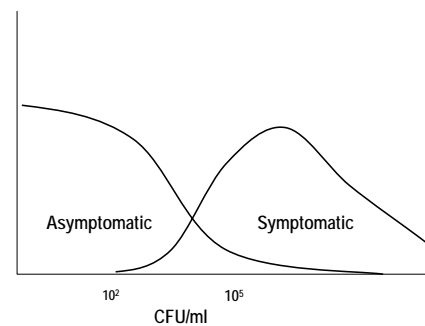


Symptomatic Women

Suprapubic Tap



Midstream Voided Urine



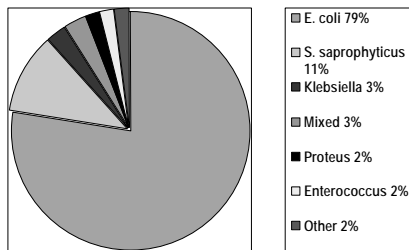
Urinary Tract Infections Populations at Risk

- Newborn
- Prepubertal girls
- Young boys
- Sexually active young women
- Elderly males
- Elderly females

Epidemiology of Urinary Tract Infections by Age Group

Age	Females		Males	
	Prevalence	Risk Factor	Prevalence	Risk Factor
<1	1%	Anatomic or functional urologic abnormalities	1%	Anatomic or functional urologic abnormalities
1-5	4.5%	Congenital abnormalities, vesicoureteral reflux	0.5%	Congenital abnormalities, uncircumcised penis
6-15	4.4%	Vesicoureteral reflux	0.5%	None
16-35	20%	Sexual activity, diaphragm use, spermicides	0.5%	Homosexual activity, anal intercourse
36-65	35%	Gynecologic surgery, bladder prolapse	20%	BPH, obstruction, catheterization, surgery
>65	40%	All of above, incontinence, chronic catheterization	35%	All of above, incontinence, chronic catheterization, condom catheters

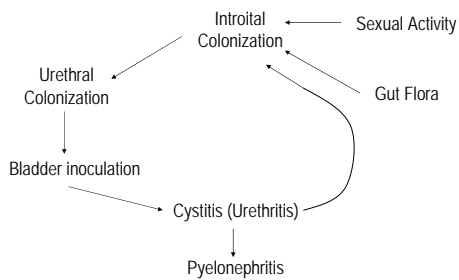
Urinary Tract Infections Infecting Organisms



Microbial Species Most Often Associated with Specific Types of UTI's

Organism	Acute uncomplicated cystitis	Acute uncomplicated pyelonephritis	Complicated UTI	Catheter-associated UTI
<i>E. coli</i>	79%	89%	32%	24%
<i>S. saprophyticus</i>	11%	0%	1%	0%
<i>P. mirabilis</i>	2%	4%	4%	6%
<i>Klebsiella</i> spp.	3%	4%	5%	8%
<i>Enterococcus</i> spp.	2%	0%	22%	7%
<i>Ps. aeruginosa</i>	0%	0%	20%	9%
Mixed	3%	5%	10%	11%
Other*	0%	2%	5%	10%
<i>Candida</i> spp.	0%	0%	1%	28%
<i>S. epidermidis</i>	0%	0%	15%	8%

**Serratia*, *Providencia*, *Enterobacter*, *Acinetobacter*, *Citrobacter*



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WIDESPREAD DISTRIBUTION OF URINARY TRACT INFECTIONS CAUSED BY A MULTIDRUG-RESISTANT ESCHERICHIA COLI CLONAL GROUP

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UTI in Women - Host Factors

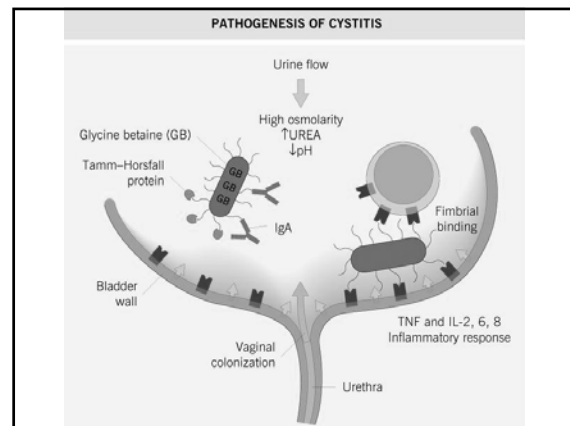
- Short urethra
- Vaginal colonization
- Diaphragm / vaginal spermicide
- Sexual intercourse
- Delayed post-coital voiding
- P₁ blood group - upper UTI

UTI - Other Host Factors

- Extra-renal obstruction
 - posterior urethral valves
 - urethral strictures
 - prostatic hypertrophy
- Neurogenic bladder
- Vesico-ureteral reflux
- Catheterization/instrumentation

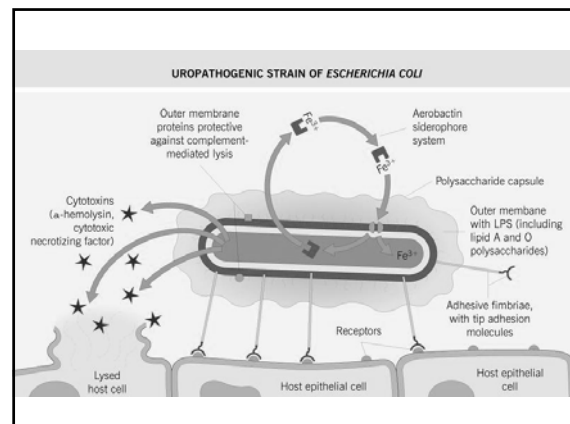
Urinary Tract Infections

- The initial pathogenic event in UTI is an encounter between bacteria and host mucosa at the tissue surface
- Attachment, binding of bacteria to mucosal cells, is the result of multiple interactions between bacterial surface ligands (adhesins) and epithelial cells (receptors).



Anti-adherence Mechanisms in the Urinary Tract

- Normal bacterial flora of vaginal, introital, and periurethral region and urethra
- Uromucoid (Tamm-Horsfall protein)
- Urinary oligosaccharides
- Urinary immunoglobulins (IgG, IgA, S-IgA)
- Bladder mucopolysaccharide (glycosaminoglycan)
- Mechanical effects of flushing



UTI - Bacterial Factors - 1

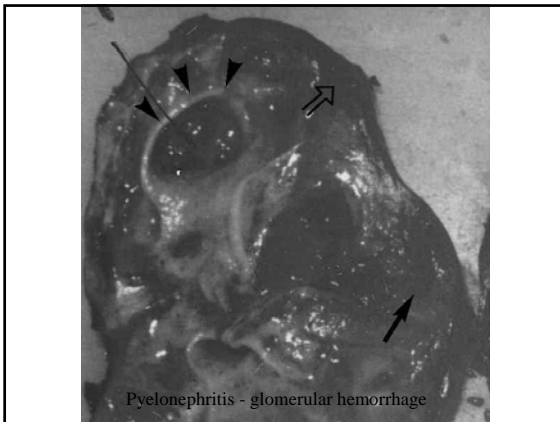
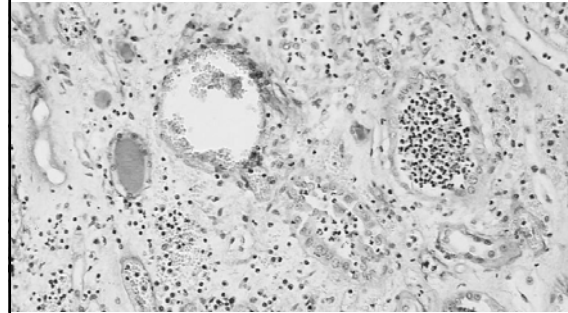
- Attachment
 - Type 1 fimbriae (MS-adhesins) - attach to mannosides on urothelial cell
 - P fimbriae - attach to globoseries receptors on urothelial cell - these strains cause pyelonephritis
 - 97% of women with recurrent pyelo are P1 blood group (+)
 - women with pyelo due to VU reflux - same prevalence of P1 as gen. pop.
 - Afimbrial adhesins (AFA I, AFA III)
- Toxins
 - RTX hemolysins - protein toxins that contain a tandem duplication of 9 amino acids (cause pores in cell membrane, lysis)
 - *E. coli* that do not produce these toxins are less virulent
- Phase variation
 - Type I down-regulated, Type P upregulated in strains that cause upper-tract infections (PAP gene expression triggered by temperature, [glucose], concentration of certain amino acids.

UTI - Bacterial Factors - 2

- Internalization
 - enters bladder cells, protected from antibody, phagocytes
 - intracellular persists - ??source of recurrent infection
- Doubling time
 - if <50 - 60 minutes, increased ability to cause cystitis
 - *E. coli* bowel strains that do not cause UTI's generally have slower doubling times
- Serum-resistant capsules
- Anti-phagocytic mechanisms (e.g., P-fimbriae)
- Iron acquisition efficiency is a virulence factor
 - uropathogenic strains may have multiple sequestration systems

UTI - Clinical

- Children
 - < 2 years - enuresis, fever, poor weight gain
 - > 3 years - dysuria, lower abdominal pain
- Adults
 - urgency, frequency, dysuria, cloudy or malodorous urine, bladder or flank pain
 - Pyelo: fever >101 F, chills (bacteremia), flank pain and tenderness



Urinary Catheters

- Foreign body
- Biofilm formation
 - bacteria, bacterial glycocalyxes, host proteins, urinary salts (apatite and struvite)
- Sanctuary site for bacteria
- Condom catheters carry same risk of infection as indwelling (Foley) catheters
- 100% become infected in 7-10 days

Bacteriuria in the Catheterized Patient

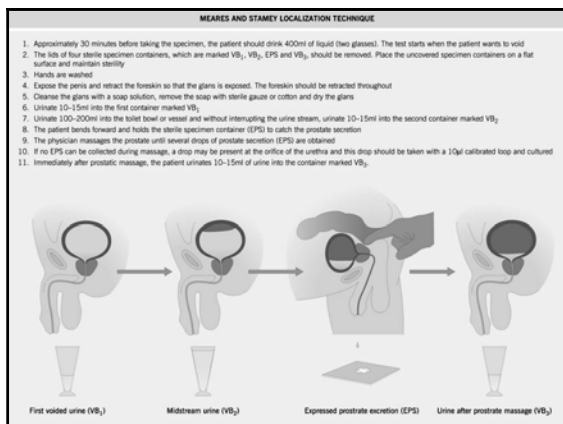
- Avoid use of antimicrobials, if possible
- Indications for treatment
 - symptomatic infection
 - suspected sepsis
 - renal transplant
 - immunocompromised patient
 - pre-operative patient
- Remove or change catheter during treatment

UTI - Diagnostic Criteria

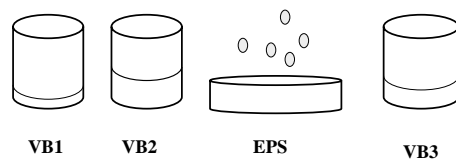
- U/A microscopic - quantitative
- Leukocyte esterase test
- Nitrate → nitrite test
- Leukocyte esterase / nitrate test
- Gram's stain, unspun urine

UTI - Diagnostic Criteria

- Collection: clean midstream specimen or straight-catheterized specimen
- >10 WBC/ μ L in symptomatic female
- (+) Gram's stain of unspun urine
- Culture criteria
 - >10⁵ CFU/mL = infection
 - symptomatic female: 10²-10⁴ CFU/mL of *E. coli*, *Proteus*, *S. saprophyticus* are significant



UTI - Stamey Test

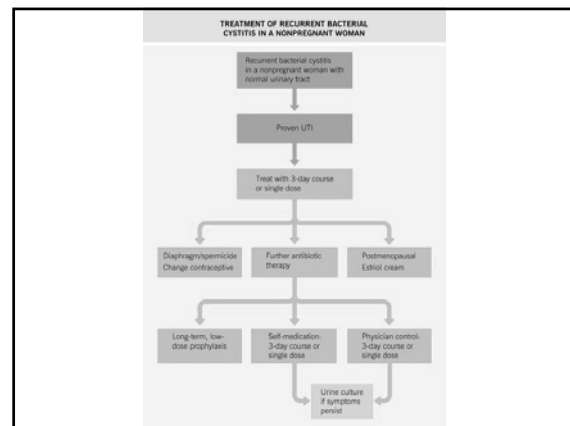
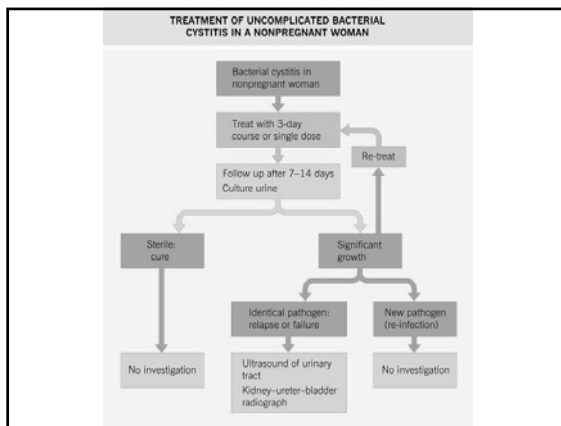


Indications for Evaluating the Urinary Tract

- Children
 - ultrasound, IVP, VCUG
- Bacteremic pyelonephritis
 - ultrasound, or IVP
- Nephrolithiasis or Neurogenic Bladder
 - ultrasound, or IVP with post-voiding films
- Men with 1st infection
 - careful prostate examination
- Men with 2nd infection
 - ultrasound or IVP with post-voiding films

General Principles of Treatment

- Quantitative cultures may be unnecessary before treatment of typical cases of acute uncomplicated cystitis.
- Susceptibility testing is necessary in all recurrent or complicated infections, perhaps not for uncomplicated cases.
- Identify or correct factors predisposing to infection (obstruction, calculi)
- relief of symptoms may not indicate bacteriologic cure: follow-up cultures are indicated if symptoms recur.
- Duration of therapy depends on the site and duration of the infection.
- Classify recurrences as re-infection or relapse.



Treatment of Asymptomatic Bacteriuria

- Pregnancy
- Neurological or structural abnormality of the urinary tract with $> 10^5$ CFU/mL
- Pre-op for GU (and other?) surgery

