# Epidemiology and prevention of urinary tract infection

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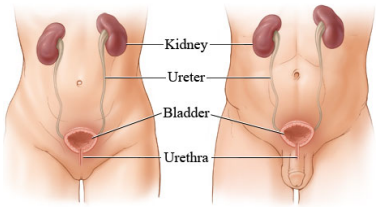
## This presentation will focus on …

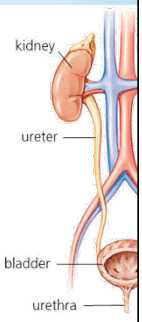
- Patients with indwelling catheterization
  - short-term (<30 days) and long-term (30 days)
  - intermittent catheterization and condom catheterization
- If not differently mentioned the content of the presentation is based on:
  - Lo et al. SHEA/IDSA Practice Recommendations
    - Infection Control Hospital Epidemiology 2008;29:S41-S50
  - B. Trautner, Management of CA-UTI
    - Current Opinion in Infectious Diseases 2010, 23:76 – 82
  - IDSA guideline
    - Clinical Infectious Diseases 2010;50:625–663

## Urinary Tract




## Urinary Tract (UT)

- Kidneys
  - Remove excess liquid and wastes from the blood
  - Keep stable balance of salts and other substances in the blood
  - Hormone producer
- Ureter
  - Carry urine from the pyelum of the kidney to the bladder
- Bladder
  - Storage of urine
- Urethra
  - Distal part of the UT
  - differences in length between males and females
- Prostate (men)
  - Is embedded around the urethra

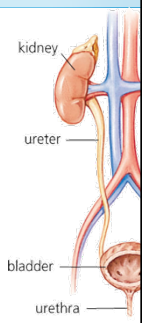



## Urine

- Urine is normally sterile
- Contains in the fluid salts and waste products
  - NOT albumin, erythrocytes, leukocytes, glucose e.o.
  - NOT: crystalline structures
- pH from 4-6
- Osmolarity: 200 - 900 mmol/L
- Unrestricted flow, no reflux, no bladder residues

## Urinary Tract Infections (1)

- Microbial invasion of any of the tissues of the UT
  - From the renal cortex to the urethral meatus
    - descending infection
  - From the urethral meatus to the renal cortex
    - ascending infection
- Even the blood can be reached by the bacteria leading to bacteraemia or sepsis



## Urinary Tract Infections (2)

- Predominantly restricted at a single site
  - Kidney: Pyelonephritis - including proximal ureters
  - Bladder: Cystitis
  - Urethra: Urethritis
  - Prostate: Prostatitis
  - Urine: Bladder bateriuria
- Recurrent infections

## Urinary Tract Infections

- Asymptomatic UTI
  - Bacteriuria
- Symptomatic UTI
  - UTI in which no underlying structural or neurological lesions are present
  - Generally respond well to antimicrobial treatment
  - Lower UTI: acute uncomplicated UTI (cystitis)
  - Upper UTI: acute non-obstructive pyelonephritis

Lindsay Nicolle, www.medscape.com/viewarticle/410143

## Urinary Tract Infections

- Complicated UTI
  - Interfere with drainage of urine in some part of the UT due to:
    - Recurrent infections, leaving residual inflammatory changes
    - Obstruction, stones or neurological lesions or abnormal UT.
  - Different species over time.
  - Risk of emergence of resistance due to frequent treatment.
  - Can be asymptomatic or symptomatic
  - Can be lower- or upper-UT

Lindsay Nicolle, www.medscape.com/viewarticle/410143

## Catheter-associated UTI (CA-UTI)

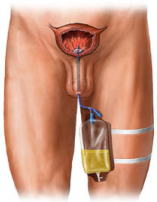

## CA-UTI

- Most common hospital-acquired infection
  - >40% of all HAIs
- 80% attributable to an indwelling urethral catheter
- 15%-25% of patients in general hospitals have a urethral catheter inserted at some time during their stay
- Daily risk of infection while catheter in-situ: 3%-7%
- While in itself low morbidity it has still a substantial burden doe to its high frequency:
  - Hospital stays extended by 2 days (attributable)
  - 2nd most common cause of nosocomial BSI
  - Large reservoir of multi-resistant m.o.'s (as a result of high AB-use)

## Predisposing factor = urinary catheterization

- → disturbs the host defense mechanisms and provides easier access of uro-pathogens to the bladder.

Foley catheter



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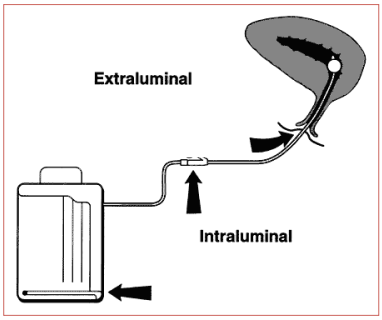
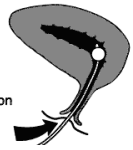
## Routes of entry of uro-pathogens to catheterized urinary tract

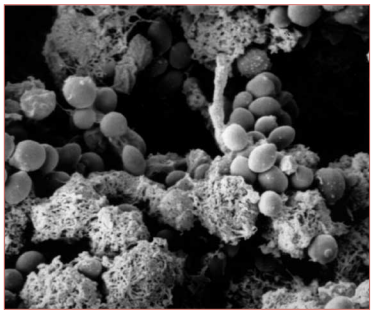



## Routes of entry of uropathogens to catheterized urinary tract




- Approximately two-thirds of the uro-pathogens that cause CA-bacteriuria are **extraluminally** acquired by ascension along the catheter-urethral mucosa interface
- Extraluminal of greater importance especially in women (proximity anus, short urethra) → periurethral colonization = risk factor

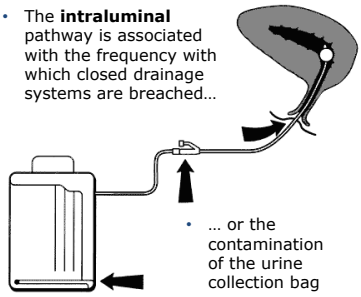
## Scanning electron micrograph of an infected catheter showing biofilm on the extraluminal surface.



(X 5000)

## Routes of entry of uropathogens to catheterized urinary tract

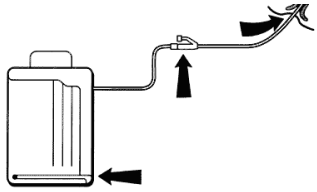
- The **intraluminal** pathway is associated with the frequency with which closed drainage systems are breached…



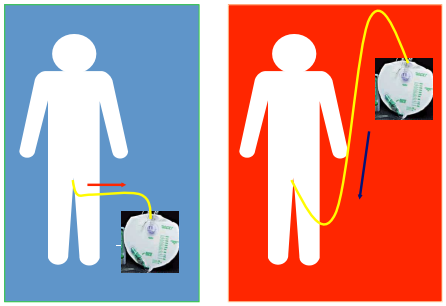
- … or the contamination of the urine collection bag

## Routes of entry of uropathogens to catheterized urinary tract

- Mass transportation of microbe-laden urine into the bladder by retrograde reflux



## CA-UTI pathogenesis



## Diagnosing CA-UTI

In patients with indwelling urethral, indwelling suprapubic, or intermittent catheterization

- Defined by the presence of symptoms or signs compatible with UTI with no other identified source of infection, along with
- $10^3$ colony-forming units (cfu)/mL of 1 bacterial species in a single catheter urine specimen (sample via needle from sampling port)

## Microbiology

- Bacteriuria in patients with **short-term catheters** is usually caused by a **single** organism.
- *Escherichia coli* is the most frequent species isolated, although it comprises fewer than one-third of isolates.
  - Other *Klebsiella* species, *Serratia* species, *Citrobacter* species, and *Enterobacter* species, *P. aeruginosa*, and gram-positive cocci, including CNS and *Enterococcus* species.
- Funguria, mostly candiduria, is reported in 3%–32% of patients catheterized for short periods of time.
- UTIs in patients with **long-term catheterization** are usually **polymicrobial**.
  - Additional pathogens *P. mirabilis*, *Morganella morganii*, and *P. stuartii* are common.

## Microbial pathogens causing nosocomial CA-UTIs in U.S. acute-care hospitals, 1990-92

| Pathogens | Hospitalwide (% of total) | Intensive care units (% of total) |
|---|---|---|
| *Escherichia coli* | 26 | 18 |
| Enterococci | 16 | 13 |
| *P. aeruginosa* | 12 | 11 |
| *Kleb./Enterob* | 12 | 13 |
| *Candida* spp. | 9 | 25 |

Jarvis WR, Martone WJ. J Antimicrob Chemother 1992;29:19-24.

## CA-UTI risk factors

- Duration of catheterization
- Female sex
- Older age
- Not maintaining a closed drainage system

## Risk factors for CA-UTI (1)

| Factor | RR | |
|---|---|---|
| Catheterization >6d | 5.1 – 6.8 | by day 30 nearly 100% of the pts |
| Female | 2.5 – 3.7 | |
| Urology service | 2.0 – 4.0 | |
| Other site of infection | 2.3 – 2.4 | |
| Diabetes | 2.2 – 2.3 | |

* based on prospective studies and use of multivariable statistical modeling

## Risk factors for CA-UTI (1)

| Factor | RR |
|---|---|
| Malnutrition | 2.4 |
| Azotemia (creat > 2.0 mg/dl) | 2.1 – 2.6 |
| Ureteral stent | 2.5 |
| Urine output monitoring | 2.0 |
| Drainage tube position | 1.9 |
| Antimicrobial Rx | 0.2 |

for short-term protective, cave selection of MR-m.o.'s

* based on prospective studies and use of multivariable statistical modeling

## Basic practices for prevention and monitoring of CA-UTI

recommended for all acute care hospitals

For exact details look at SHEA/IDSA Practice Recommendations
Infection Control Hospital Epidemiology 2008;29:S41-S50

## Basic practices for prevention and monitoring of CA-UTI

A. Appropriate infrastructure for preventing CA-UTI
B. Surveillance of CA-UTI
C. Education and training
D. Appropriate technique for catheter insertion
E. Appropriate management of indwelling catheters
F. Accountability

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## A. Appropriate infrastructure for preventing CA-UTI

- Provide and implement written guidelines for catheter use, insertion, and maintenance
- Ensure that only trained, dedicated personnel insert urinary catheters
- Ensure that supplies necessary for aseptic-technique catheter insertion are available
- Document indications for catheter insertion, date and time of catheter insertion, individual who inserted catheter, and date and time of catheter removal
- Resources to support surveillance of catheter use and outcomes

For exact details look at SHEA/IDSA Practice Recommendations ICHE 2008;29:S41-S50

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## Surveillance of CA-UTI

- Use standardized criteria to identify patients who have a CA-UTI (**numerator** data)
- Collect information on catheter-days (**denominator** data) for all patients in the patient groups or units being monitored

## Basic practices for prevention and monitoring of CA-UTI

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## Education and training

- Educate HCWS involved in insertion, care, and maintenance of urinary catheters
  - including alternatives to indwelling catheters
  - procedures for catheter insertion, management, and removal

## Basic practices for prevention and monitoring of CA-UTI

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## Appropriate technique for catheter insertion

- Practice hand hygiene
  - immediately before insertion of the catheter
  - before and after any manipulation of the catheter site.
- Insert catheters by use of aseptic technique and sterile equipment.
- Use gloves, a drape, and sponges;
  - a sterile or antiseptic solution for cleaning the urethral meatus
  - single-use packet of sterile lubricant jelly for insertion.
- Use as small a catheter as possible that is consistent with proper drainage, to minimize urethral trauma.

## Basic practices for prevention and monitoring of CA-UTI

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## Appropriate management of indwelling catheters (1)

- Properly secure indwelling catheters after insertion to prevent movement and urethral traction.
- Maintain a sterile, continuously closed drainage system.
- Do not disconnect the catheter and drainage tube unless the catheter must be irrigated.
- If needed, replace the collecting system by use of aseptic technique and after disinfecting the catheter-tubing junction.

## Appropriate management of indwelling catheters (2)

- Collect urine sample by aspirating urine from the sampling port with a sterile needle and syringe after cleansing the port with disinfectant.
- Maintain unobstructed urine flow.
- Empty the collecting bag regularly, using a separate collecting container for each patient.
- Keep the collecting bag below the level of the bladder at all times.
- Cleaning the meatal area with antiseptic solutions is unnecessary; routine hygiene is appropriate.

## Basic practices for prevention and monitoring of CA-UTI

A. Appropriate infrastructure for preventing CA-UTI
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F. Accountability

## Accountability

- The hospital's chief executive officer, senior management and all HCWs are responsible to fascilitate and implement the structure and measures to effectively prevents CA-UTIs.

## Approaches that should not be considered a routine part of CA-UTI prevention

For exact details look at SHEA/IDSA Practice Recommendations Infection Control Hospital Epidemiology 2008;29:S41-S50

## Do not consider

- Do not screen for asymptomatic bacteruria in catheterized patients.
- Avoid catheter irrigation.
  - Do not perform continuous irrigation of the bladder with antimicrobials as a routine infection prevention measure
- Do not use systemic antimicrobials routinely as prophylaxis.
- Do not change catheters routinely.
- Do not **routinely** use silver-coated or other antibacterial catheters.

## Antimicrobial Coated Catheters

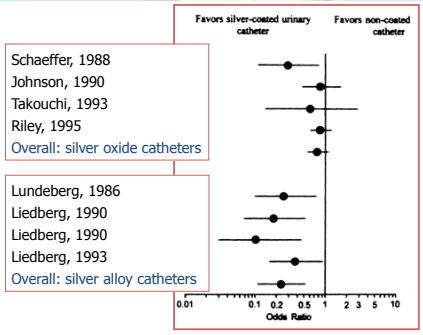
- In patients with short-term indwelling urethral catheterization, antimicrobial (silver alloy or antibiotic)–coated urinary catheters may be considered to reduce or delay the onset of CA-bacteriuria.
  - Data are insufficient to make a recommendation about whether use of such catheters reduces CA-UTI in patients with short-term indwelling urethral catheterization.
  - Data are insufficient to make a recommendation as to whether use of such catheters reduces CA-bacteriuria or CA-UTI in patients with long-term catheterization.

## Novel technology (1)

- Antiinfective catheter material

| | RR |
|---|---|
| – Antimicrobial drug-impregnated | |
| • Nitrofurazone | 0.7 |
| • Minocycline-rifampin | 0.4 |
| – Silver oxide | unproven |
| – Silver-hydrogel | 0.2 – 0.7 |

## Meta-analysis of prospective randomized trials of silver oxide and silver alloy-hydrogel catheters.



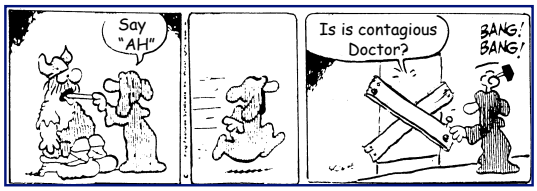

Saint et al. Am J Med 1998;105:236-4

## Novel technology (1)

| | |
|---|---|
| • Antiinfective lubricant | unproven |
| • Sealed catheter-collection tubing junctions | unproven |
| • Antireflux valves | unproven |
| • Continuous irrigation of bladder with antiinfective | unproven* |
| • Antiinfectives is col.-bag | unproven |

* increase of infections

## Seperate patients c/s catheter




## The future

- Microbe-impervious antireflux valves
- Urethral stents
  - alternative in man with obstructions
- Conformable (collapsible) urethral catheters
  - causes less trauma
- New antiseptics and surface technologies
- Vaccines for enteric Gram- and staphylococci

## Summary of Recommendations From Published Guidelines (1)

- Ensure documentation of catheter insertion
- Ensure that trained personnel insert catheter
- Train patients and family
- Practice hand hygiene
- Evaluate necessity of catheterization
- Evaluate alternative methods
- Review ongoing need regularly
- Select catheter material
- Use smallest-gauge catheter possible
- Use aseptic technique/sterile equipment
- Use barrier precautions for insertion
- Perform antiseptic cleaning of meatus

Recommended
Not discussed
- Unresolved -

## Summary of Recommendations From Published Guidelines (2)

- Use closed drainage system
- Obtain urine samples aseptically
- Replace system if a break in asepsis occurs
- Do not change catheter routinely
- Perform routine hygiene for meatal care
- Avoid irrigation
- Cohort patients
- Ensure compliance with training
- Ensure compliance with control measures
- Ensure compliance with catheter removal
- Monitor rates of CAUTI and bacteremia

Recommended
Not discussed
- Unresolved -

# UTI bundle

## UTI bundle

- Handhygiene
- Insertion kit
  - Cleaning reagent + desinfectant + lubricant
  - Sterile cover and cloves
  - Catheter and syringe
- Maintenance
  - Keeping bag low
  - Reduce contamination in manipulations
- Daily assesment
  - Need/removal

## ICPIC 2011


## Extra slides not presented on-line

## Prevention of CA-UTI

- Avoid unnecessary cathterization – remove as soon as possible
- Consider alternatives (suprapubic, condom)
- Aseptic insertion by trained professional
  (sterile gloves, fenestrated sterile drape, skin disinfection)
- Maintain closed drainage
- Ensure dependent drainage
  (below patient's bladder, but tubing above bag!)
- Minimize manipulations of the system

## Limiting Unnecessary Catheterization

- Indwelling catheters should be placed only when they are indicated.
  - Should not be used for the management of urinary incontinence (or only in exceptional cases, when all other approaches to management of incontinence failed).
- List of appropriate indications for inserting indwelling urinary catheters
  - educate staff about such indications
  - periodically assess adherence to the guidelines
- Physician's order in the chart before an indwelling catheter is placed.
- Portable bladder scanners to determine whether catheterization is necessary for postoperative patients.

## Limiting the duration of catheterization

- Indwelling urethral catheters are frequently used when not indicated or, remain in situ longer than necessary.
- Optimal approaches to limit catheter use and duration may be dependent on facility characteristics.
- Approaches to limit catheter use and duration reported to be effective include the following:
  - (a) Implementing procedure-specific guidelines for postoperative catheter removal
  - (b) Providing guidelines to manage postoperative retention, which may include the use of bladder scanners
  - (c) Providing reminders to physicians to review the need for continued catheterization and/or to remove catheters
  - (d) Development of care plans directing nurse removal of catheters for patients who meet prespecified criteria

## Alternatives to an indwelling urethral catheter

- External condom catheter drainage for men compared with a short-term indwelling urethral catheter reduced acquisition of bacteriuria and adverse outcomes and was more acceptable to the patient.
- In-and-out catheterization was as effective as the use of an indwelling catheter for management of postoperative retention.
- Fewer complications with use of a suprapubic catheter, but surgical insert is associated with additional risks.
- Current evidence is not sufficient to support the routine use of a suprapubic catheter for short-term catheterization.

## Closed Catheter System

- Use a closed catheter drainage system, with ports in the distal catheter for needle aspiration of urine
  - in patients with short-term and long-term indwelling urethral or suprapubic catheters
- Minimize disconnection of the catheter junction
- Keep the drainage bag and connecting tube always below the level of the bladder
- Use of a pre-connected system (catheter pre-attached to the tubing of a closed drainage bag) may be considered
  - data are insufficient as to whether such a system reduces CA-UTI.

## Prophylaxis with Systemic Antimicrobials

- Systemic antimicrobial prophylaxis should not be routinely used in patients with short-term (A-III) or long-term (A-II) catheterization, including patients who undergo surgical procedures, to reduce CA-bacteriuria or CA-UTI because of concern about selection of antimicrobial resistance.

## Enhanced Meatal Care

- Daily meatal cleansing with povidone-iodine solution, silver sulfadiazine, polyantibiotic ointment or cream, or green soap and water is not recommended for routine use in men or women with indwelling urethral catheters to reduce CA-bacteriuria (A-I).i.Data are insufficient to make a recommendation as to whether meatal cleansing reduces the risk of CA-UTI.

## Catheter Irrigation

- Catheter irrigation with antimicrobials should not be used routinely to reduce or eradicate CA-bacteriuria (A-I) or CA-UTI (A-II) in patients with indwelling catheters.36. Catheter irrigation with antimicrobials may be considered in selected patients who undergo surgical procedures and short-term catheterization to reduce CA-bacteriuria (C-I).i.Data are insufficient to make a recommendation about whether bladder irrigation in such patients reduces CA-UTI.37. Catheter irrigation with normal saline should not be used routinely to reduce CA-bacteriuria, CA- UTI, or obstruction in patients with long-term indwelling catheterization (B-II).

## Routine Catheter Change

- Data are insufficient to make a recommendation as to whether routine catheter change (eg, every 2–4 weeks) in patients with functional long-term indwelling urethral or suprapubic catheters reduces the risk of CA-ASB or CA-UTI, even in patients who experience repeated early catheter blockage from encrustation.

## Prophylactic Antimicrobials at Time of Catheter Removal or Replacement

- Prophylactic antimicrobials, given systemically or by bladder irrigation, should not be administered routinely to patients at the time of catheter placement to reduce CA-UTI (A-I) or at the time of catheter removal (B-I) or replacement (A-III) to reduce CA-bacteriuria.i.Data are insufficient to make a recommendation as to whether administration of prophylactic antimicrobials to such patients reduces bacteremia.

## Urine Culture and Catheter Replacement before Treatment

- A urine specimen for culture should be obtained prior to initiating antimicrobial therapy for presumed CA-UTI because of the wide spectrum of potential infecting organisms and the increased likelihood of antimicrobial resistance (A-III).46. If an indwelling catheter has been in place for >2 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 (A-I).i.The urine culture should be obtained from the freshly placed catheter prior to the initiation of antimicrobial therapy to help guide treatment (A-II).ii.If use of the catheter can be discontinued, a culture of a voided midstream urine specimen should be obtained prior to the initiation of antimicrobial therapy to help guide treatment (A-III).

## Duration of Treatment

- Seven days is the recommended duration of antimicrobial treatment for patients with CA-UTI who have prompt resolution of symptoms (A-III), and 10–14 days of treatment is recommended for those with a delayed response (A-III), regardless of whether the patient remains catheterized or not.i.A 5-day regimen of levofloxacin may be considered in patients with CA-UTI who are not severely ill (B-III). Data are insufficient to make such a recommendation about other fluoroquinolones.ii.A 3-day antimicrobial regimen may be considered for women aged65 years who develop CA- UTI without upper urinary tract symptoms after an indwelling catheter has been removed (B-II).

## Antimicrobials in the Drainage Bag

- Routine addition of antimicrobials or antiseptics to the drainage bag of catheterized patients should not be used to reduce CA-bacteriuria (A-I) or CA-UTI (A-I).