

Stewardship-Driven Advances in UTI Diagnosis and Management

Kim Claeys, PharmD, PhD

Associate Professor Infectious Diseases

University Of Maryland School Of Pharmacy

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Disclosures

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Learning Objectives

Be able to differentiate asymptomatic bacteriuria (ASB) from symptomatic urinary tract infections (UTIs) across patient populations.

Apply diagnostic stewardship strategies to urine culture ordering, processing, and reporting in response to clinical workflow scenarios, consistent with evidence-based practice.

Review updated guideline-concordant empiric and definitive antimicrobial therapy, including appropriate duration and de-escalation, for complicated UTIs.

Why Diagnosis is Hard and Often Wrong

UTI Pathogenesis & Clinical Relevance

Inflammation & invasion of microorganism into the urothelium of urinary tract

Causes a constellation of signs and symptoms, mostly referred to urinary tract

- Non-specific symptoms make diagnosis of true infection difficult
 - Important to differentiate from contamination and colonization from true infection
- Understanding the different classifications of UTIs is essential for management

One of the most common bacterial infections both inpatient and outpatient

- UTIs the most common infection in US physician offices ~10 million outpatient encounters/year
- National sample identified ≈2.8 million hospital discharges with UTI, ~ 8% of all admissions
- In nursing homes, UTI 30-day prevalence is 5.6–8.1%, estimated 1.1–2.7 million per year

Appropriate Clinical Indications

Patients without Urinary Catheters

Appropriate

Dysuria, suprapubic pain, flank pain, Costovertebral angle (CVA) tenderness, or septic shock

Uncertain

Fever or systemic leukocytosis with no other known cause

Inappropriate

Altered mental status, or change in urine characteristics (color, sediment, smell)

Patients with Urinary Catheters

Appropriate

Dysuria, suprapubic pain flank pain, Costovertebral angle (CVA) tenderness, or septic shock

Uncertain

Fever, systemic leukocytosis with no other known cause, or delirium*

Inappropriate

Change in urine characteristics (color, sediment, smell)

UA and Urine Culture

WHAT UA SHOWS



Pyuria = Inflammation
→ Reflects immune response



Pyuria ≠ Infection
→ Can occur without infection (e.g., STIs, non-infectious causes)



Nitrites / Leukocyte Esterase
→ Supportive findings only
→ Do **NOT** confirm UTI

THE CORE MESSAGE

**Urinalysis
≠ Diagnosis**

**It provides clues,
not answers**

CULTURE IN CONTEXT



Urine Culture = Gold Standard
→ Identifies organism + susceptibilities



BUT... Context Matters
→ Symptoms
→ Patient population (e.g., older adults, catheterized)
→ Pre-test probability

HOW TO USE THESE TESTS

**Patient Symptoms
+ Clinical Context**



Urinalysis (UA)
→ Screening / supportive



Urine Culture
→ Confirmation
when appropriate



**Clinical Diagnosis
of UTI**

Asymptomatic Bacteriuria (ASB)

The Core Stewardship Problem

Asymptomatic Bacteriuria (ASB)

Presence of bacteria in urine without urinary symptoms attributable to the genitourinary tract such as dysuria, urinary urgency, or urinary frequency

Epidemiology of ASB

- Healthy adults ~ 1% to 5%
- Older adults ~ 10% to 20%
- Long-term care ~ 25% to 50%
- Chronically catheterized patients ~ 100%

Who Should NOT Be Treated

- Elderly
- Diabetes
- Catheters
- Altered mental status alone

Who SHOULD Be Treated

- Pregnancy
- Recent (<1 month) renal transplant
- Selected urologic procedures

Antibiotics are prescribed in 50% to 80% of ASB cases across practice settings

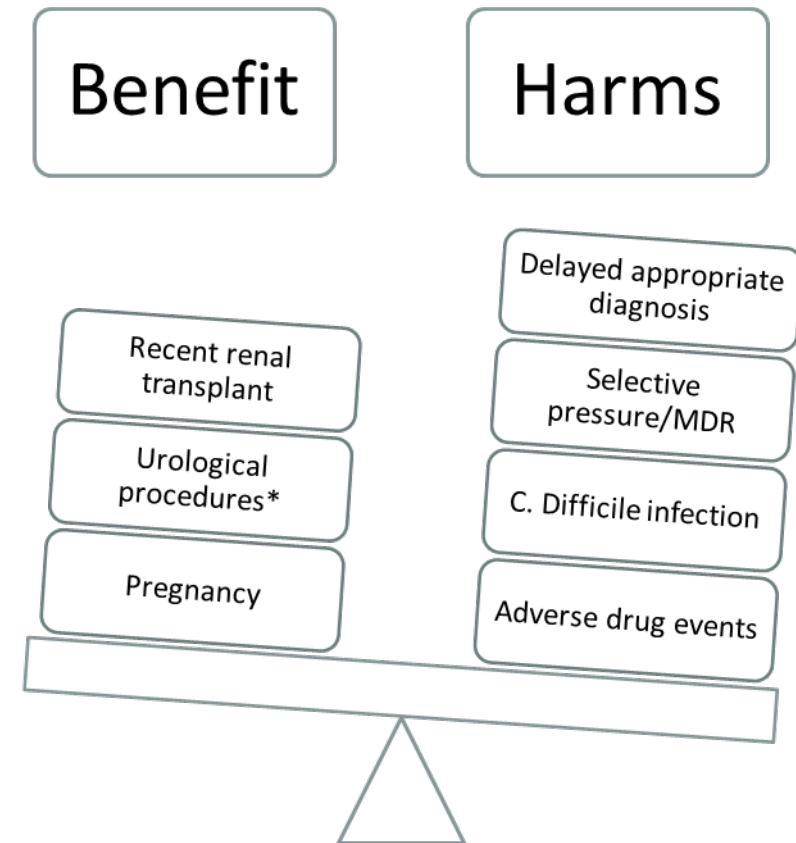
Challenges in UTI Diagnosis... ASB Problems

One of the most common bacterial diagnoses, often uncertain

Positive UA or culture leads to a UTI diagnosis even *without* urinary symptoms

Falls, AMS, or general mental decline often attributed to UTI without localizing urinary signs

Variable background presence of asymptomatic bacteriuria (ASB)



ASB Drives Antibiotic Use

Many urine cultures are ordered for vague symptoms (confusion, leukocytosis, foul-smelling urine), and many lack a clear indication

- Providers ordered urine cultures in 80% of patients with ASB
- Major drivers included dementia, spinal cord injury, incontinence, altered mental status... positive UA
- 74.4% (1830/2461) received antibiotics; median duration 6 days
- Antibiotic treatment was not associated with better clinical outcomes, instead:
 - Longer hospital stay (mean 5.1 vs 4.2 days; RR 1.16)
 - Higher *C. difficile* infection risk (0.9% vs 0%)

Patient Characteristic	Odds Ratio (95% CI)	P Value
Age	1.01 (1.00–1.02)	.006
Dementia	1.43 (1.11–1.84)	.006
Urinary catheter	1.54 (1.17–2.03)	.002
Incontinence	1.81 (1.40–2.33)	<.0001
Spinal cord injury	5.92 (1.36–25.72)	.02
Acutely altered mental status	2.34 (1.82–3.00)	<.0001
Peripheral leukocytosis^a	1.42 (1.21–1.68)	<.0001
Abnormal urinalysis^b	9.68 (5.34–17.54)	<.0001

^aDefined as white blood cells >10 000 cells/mm³.

^bDefined as presence of leukocyte esterase or nitrite, or white blood cells >5 per high-power field.

Diagnostic Stewardship

Right Test, Right Patient, Right Action

What is Diagnostic Stewardship

- Provide the *right test*, for the *right patient*, prompting the *right action*
- Goal to reduce diagnostic error → improve patient outcomes



Diagnostic Stewardship vs Diagnostic Excellence

Diagnostic Excellence:

Broader focus on accurate, timely, patient-centered diagnosis.

Diagnostic Stewardship:

Operational focus on test utilization and interpretation.

Both aim to reduce diagnostic errors and improve patient safety.

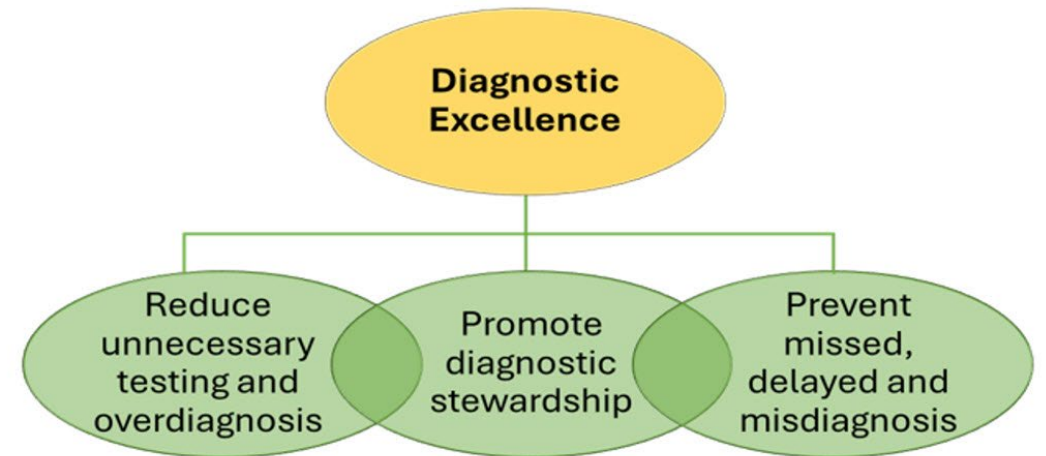


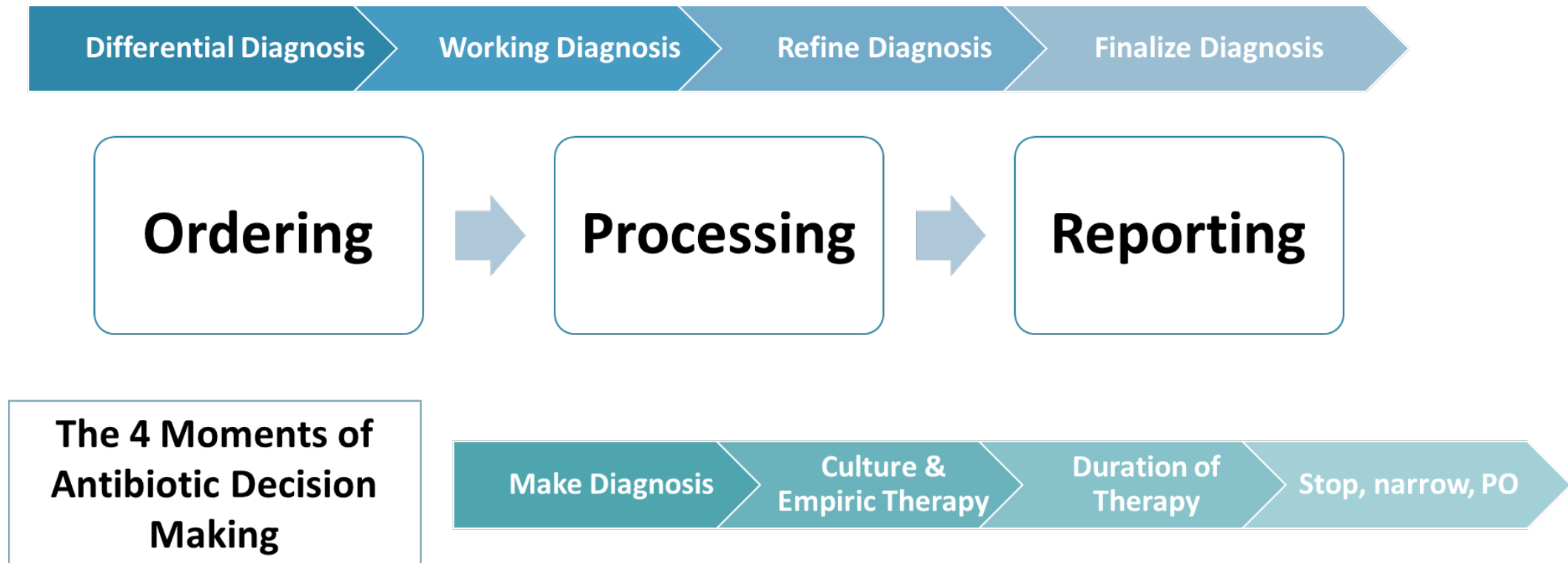
Figure 1: Diagram showing the aspects of diagnosis that are part of diagnostic excellence to be addressed by these Core Elements.

Diagnostic vs Antimicrobial Stewardship

Domain	Diagnostic Stewardship	Antimicrobial Stewardship
Goals	Improve test use; reduce diagnostic error	Improve antimicrobial use; reduce adverse events and resistance
Leadership	Microbiology, ID, pharmacy, IP, QI	ID physicians and pharmacists
Value	Decrease low-value testing	Antimicrobial cost savings
Targets	Test selection, collection, processing, reporting	Antibiotic agent, dose, route, duration
Interventions	CDS, nudges, order sets, reporting	Audit/feedback, prior auth, time-outs, IV→PO

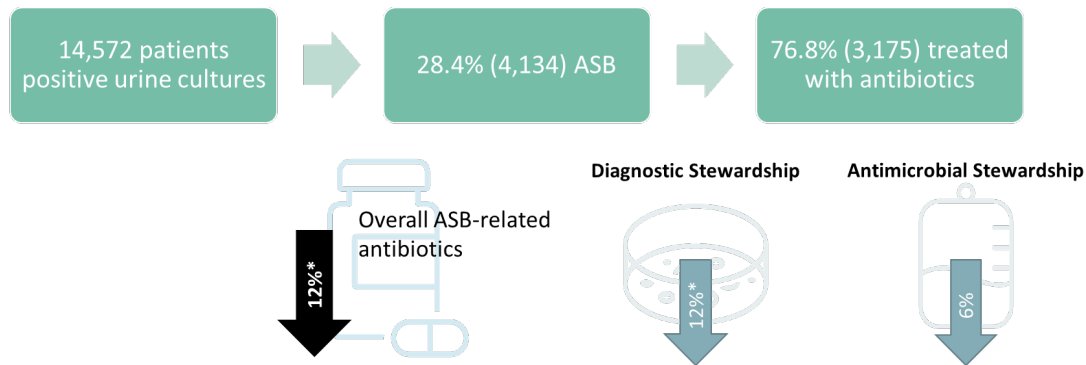
4 Moments of (UTI) Antibiotic Decision-Making

Parallel diagram showing diagnostic workflow from ordering to reporting aligned with clinical diagnosis steps and antibiotic decision-making from diagnosis to therapy optimization.



Diagnostic Stewardship & Antibiotic Use

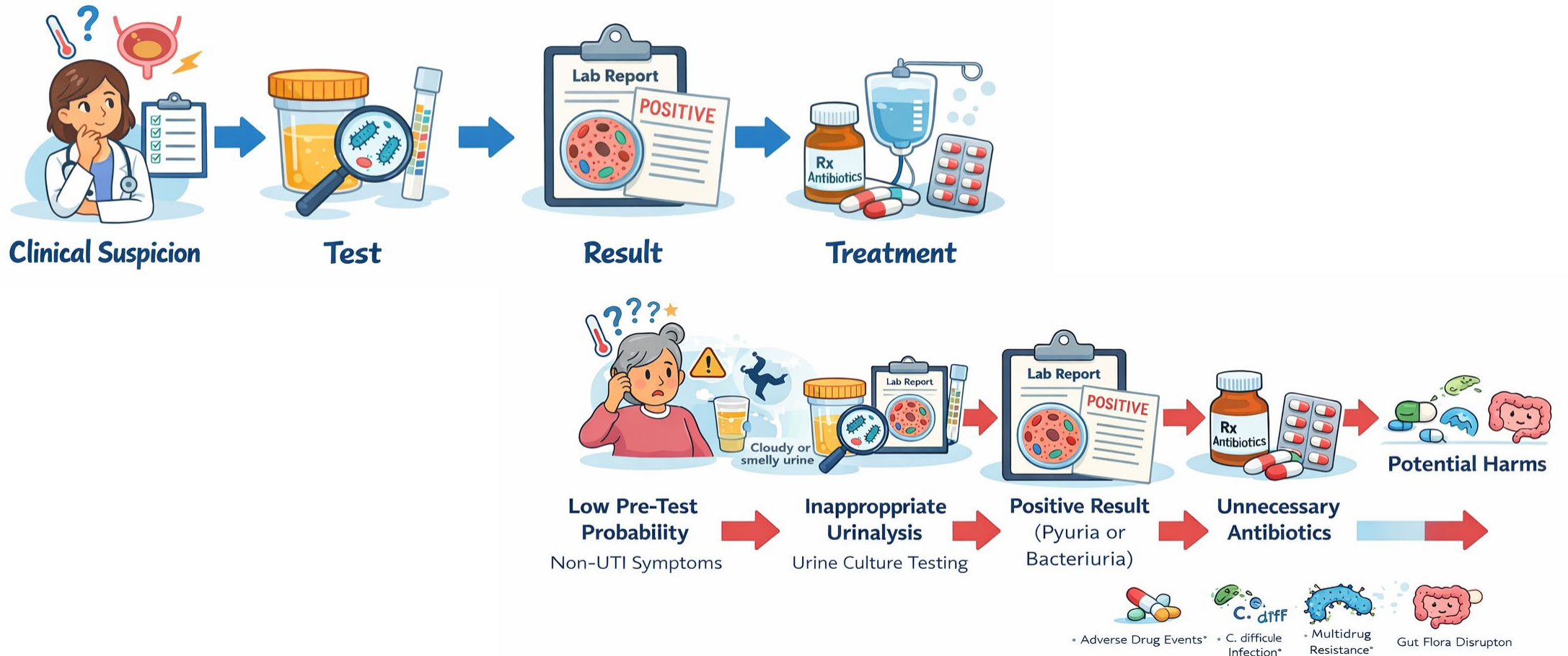
- The Michigan Hospital Medicine Safety Consortium (46 hospitals)



- Goal to decrease inappropriate diagnosis of UTI/treatment of ASB
- Both antimicrobial and diagnostic stewardship worked, but the main driver was stopping the urine culture from even being ordered

Vaughn VM, et al. JAMA Intern Med. 2020 Sep 1;180(9):1252-1261

How Diagnostic Decisions Drive Antibiotic Use



Pre-Analytic Phase: Ordering

Appropriate Practices

1. Require documentation of signs or symptoms of UTI
2. Replace stand-alone urine culture orders with conditional urine cultures**
3. Implement alerts to discourage ordering urine cultures in the absence of signs or symptoms of UTI*
4. Automatically cancel repeat urine cultures within 5 days of a positive culture

Inappropriate Practices

1. Include urine cultures in standard order sets for:
 - ED evaluation
 - Hospital admission
 - Inpatient pre-op
 - Assessment of altered mental status
 - Assessment of falls in long-term care
2. Order urine cultures in response to change in urine characteristics (i.e., smell)

* Except for patients undergoing urological procedures

+ Disagreement around use in urinary catheters and the ER setting

Changing How Tests are Ordered

Multi-center: adult inpatient & outpatient sites
Addition of order set in the EMR

- Added: Type of urine study, guideline concordant indications
- Changed: UA with reflex to culture
- UA with reflex to culture **requires** clinical indications

Urinalysis w/Microscopic + Reflex to Culture

Priority: Routine | Routine | ASAP

Frequency: Once | Once | Tomor: AM | Daily AM Labs | Daily

Starting: 6/22/2018 | Today | Tomorrow | At: 1010

First Occurrence: Today 1010

Specimen Source: Urine

Urine, Clean Catch | Urine, Voided | Urine, Foley | Urine, Sterile Collection | Urine, R
Urine, Suprapubic Aspirate | Urine, Urostomy | Urine, Surgically Obtained, Urine

Indications: Fever or rigors with no other identifiable cause
Altered mental state, malaise or lethargy wno Identfable cause
Flank pain or CVA tenderness | Acute hematuria
Dysuria, urinary urgency, frequency, suprapubic or tiernders
In patients with spinal cord injury: incread spasticity, autonomic

Add-on: Urinalysis with microscopic, reflex Urine Culture solely on 10 VECs or m...

Next Required

URINALYSISI/CULTURE SET

SUSPECTED UTI (URINARY TRACT INFECTION)

Urinalysis w/Microscopic + Reflex to Culture

NON INFECTIOUS INDICATIONS

NON INFECTIOUS INDICATIONS

Urinalysis with Microscopic If Indicated

Urinalysis w/Microscopic

Urinalysis without Microscopic

SCREENING PURPOSES OR NEUTROPENIC PATIENTS WITH URINARY SYMPTOMS

SCREENING PURPOSES OR NEUTROPENIC PATIENTS WITH URINARY SYMPTOMS

Urine culture

Urinalysis withMicroscopic If Indicated

Urinalysis without Microscopic

↓ urine culture 40%

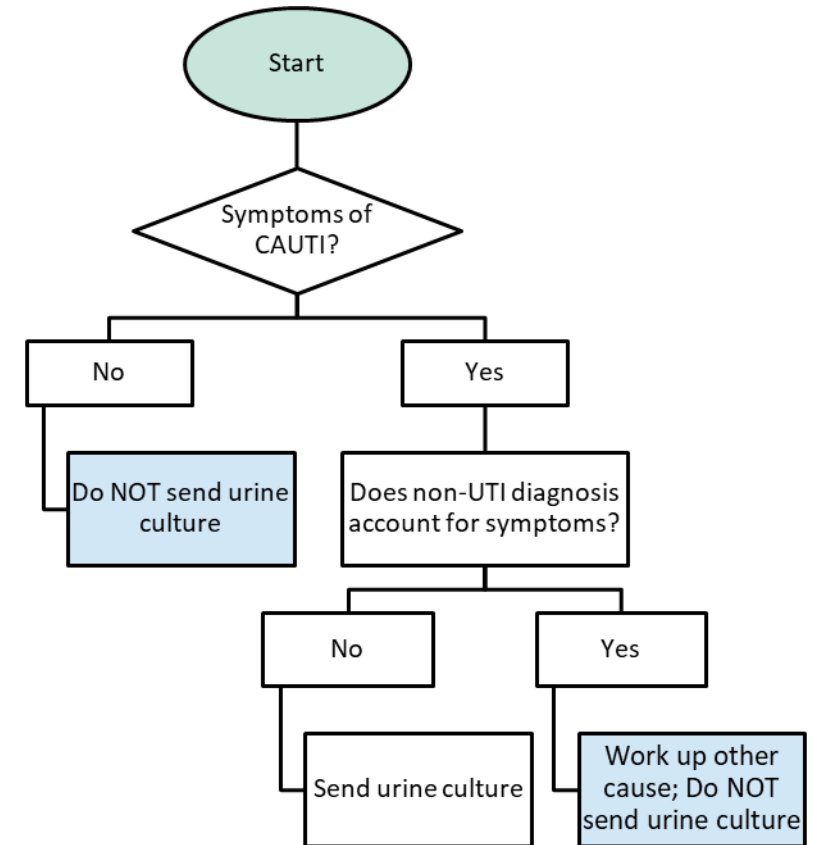
↓ UTI antibiotics DOTS 15%

VA “Kicking CA-UTI” Initiative

Multi-site stewardship QI intervention to reduce unnecessary urine cultures and antibiotics for ASB in VA facilities (acute care and long-term care)

Core Components:

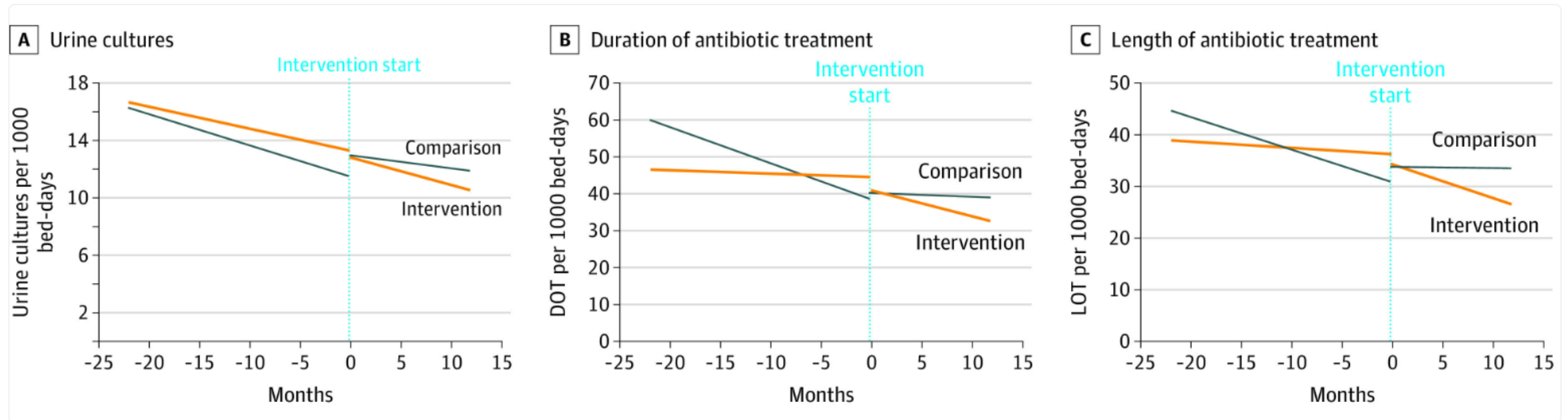
- Evidence-based “Kicking CAUTI” algorithm to distinguish UTI vs ASB
- Case-based education with interactive teaching cases, algorithm pocket cards, conferences, and in-services



VA “Kicking CA-UTI” Initiative

Primary Outcomes (standardized per 1000 bed-days)

Figure 2. Clinical Outcomes for Urine Cultures, Days of Antibiotic Therapy, and Length of Antibiotic Therapy.



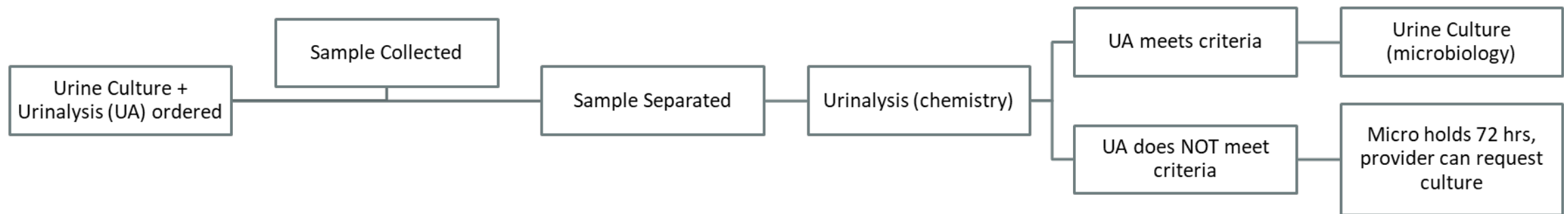
Analytic Phase: Processing

Appropriate Practices

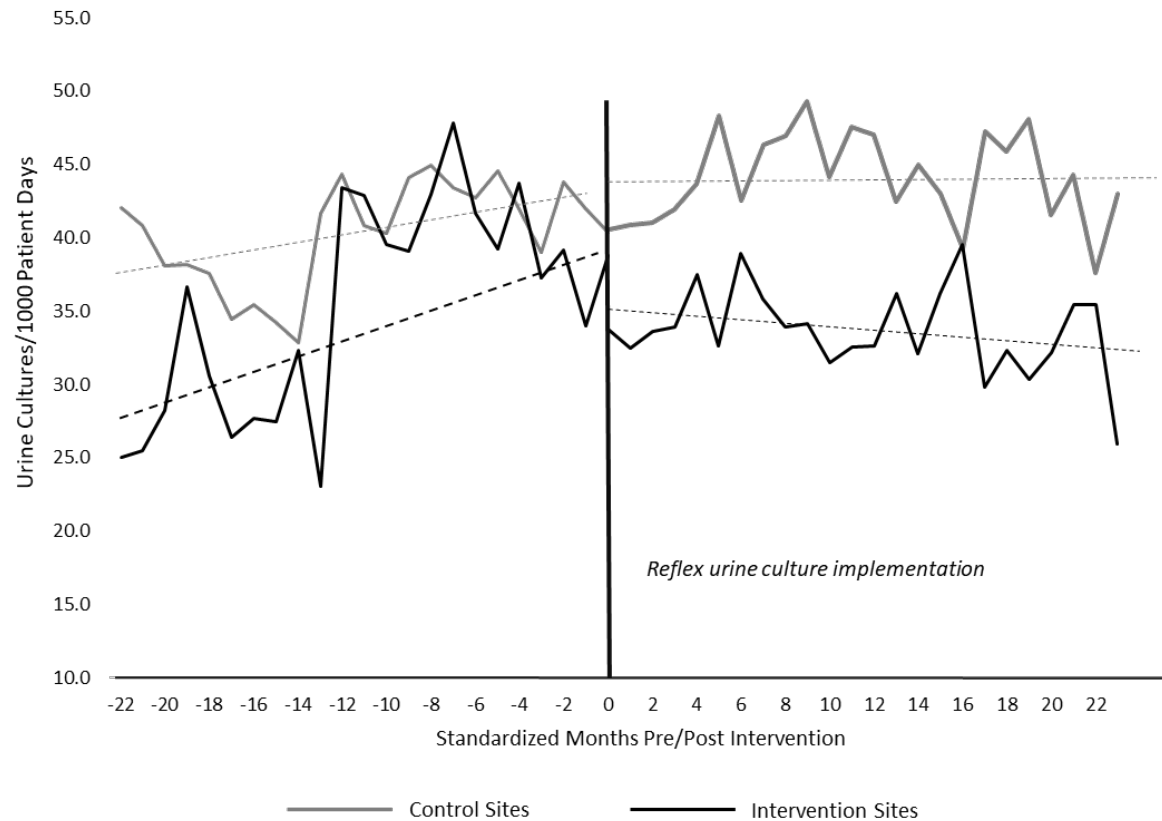
1. Use elevated urine WBC count as a criterion to reflex to urine culture when a clinician orders a urine culture (all settings)
2. Require documentation of collection site method (i.e., clean catch) prior to processing urine cultures

Inappropriate Practices

1. Automatically reflex routine urinalyses to urine cultures for abnormal findings when a urine culture was not specifically requested by the ordering clinician



Conditional Urine Reflex Culturing in the VA



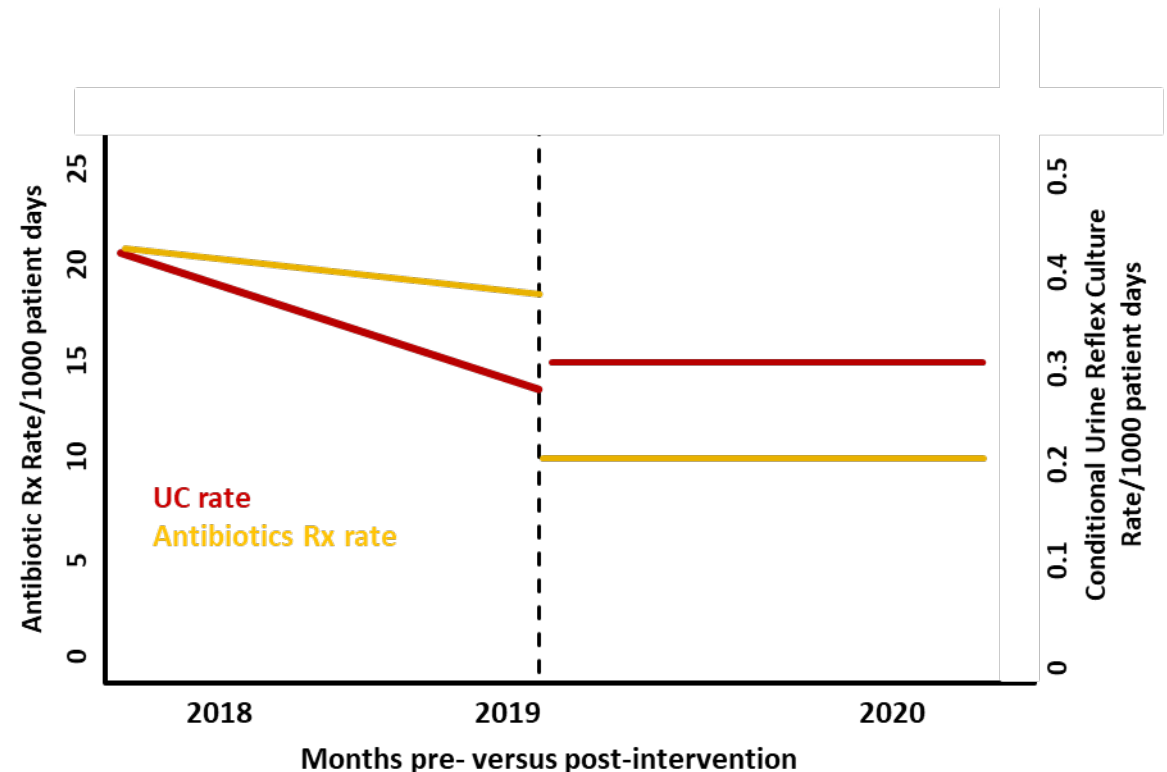
Across 50,901 admissions

- Site with conditional reflex culturing had a 21% relative decrease in rate of urine cultures performed ($P < 0.01$)
- Gram-negative BSI did not increase

WBC Thresholds for Urine Culturing

Pre/-post-study changing reflex criteria from $\geq 5 \times 10^9/\text{L}$ WBC OR positive LE OR positive nitrites
→ $\geq 15 \times 10^9/\text{L}$ WBC

- ↓ in urine culture performance per 1,000 PDs (35.2 to 8.6, $P < 0.001$)
- ↑ culture positivity (34.8% to 61.2%, $P = 0.01$)
- ↓ antibiotic prescriptions per 1,000 PDs (20.5 to 14.2, $P = 0.04$)



Post-Analytic Phase: Reporting

Appropriate

1. Add interpretive comments:
 - High colony counts ≠ infection without symptoms
 - Do not treat asymptomatic bacteriuria
 - Do not treat mixed flora
 - Distinguish pathogens vs contaminants
2. Withhold results when >2 organisms identified
3. Report guideline-preferred antibiotics only
4. Suppress fluoroquinolones unless needed

Inappropriate

1. Nudging clinicians to treat based on CFU thresholds alone
 - (e.g., suggesting treatment for <100,000 CFU without clinical context)
2. Withholding organism identification or susceptibilities
 - Unless the clinician contacts the microbiology laboratory

Guidance is for all healthcare settings unless specifically noted. These recommendations apply to symptomatic patients only. Patients that do not have symptoms of urinary tract infection should not be cultured.
‡Due to expert disagreement, this recommendation does not extend to those undergoing a urological procedure

Post-Analytic Phase: Reporting

NUDGES

Behavioral interventions to guide decision making through choice architecture

FRAMING

Presenting choices to highlight positive or negative aspects of a decision, changing their relative attractiveness

CASCADE REPORTING

Report only narrow spectrum agents, when possible, report broader agents if resistance present

SELECTIVE REPORTING

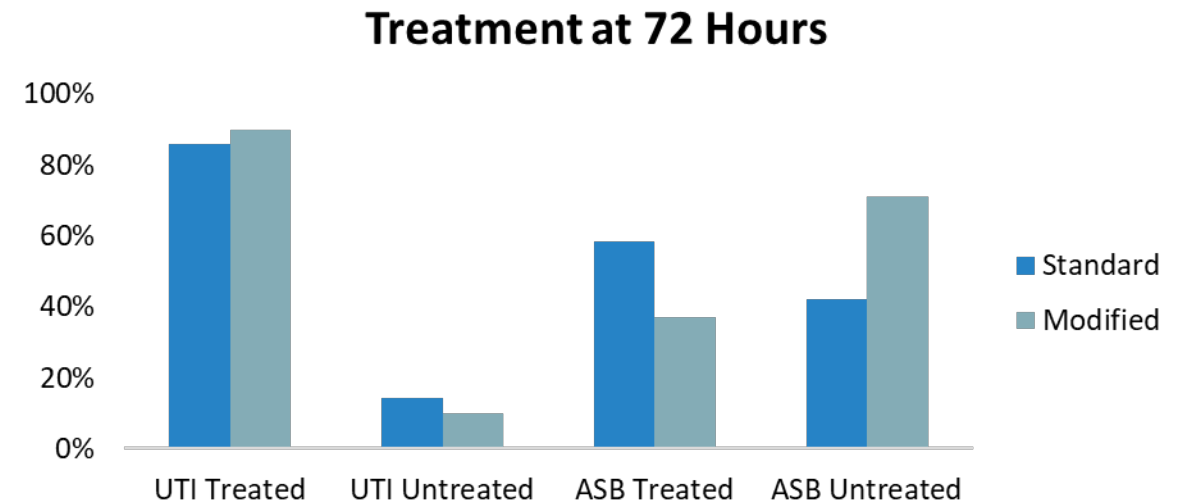
Restrict reporting of agents based on pre-defined criteria (i.e., intrinsic resistance, high ADE)

Modified Reporting of Urine Cultures

Single-center randomized clinical trial
Adult nonpregnant, non-catheterized acute
care inpatients
Standard versus modified urine culture
reporting

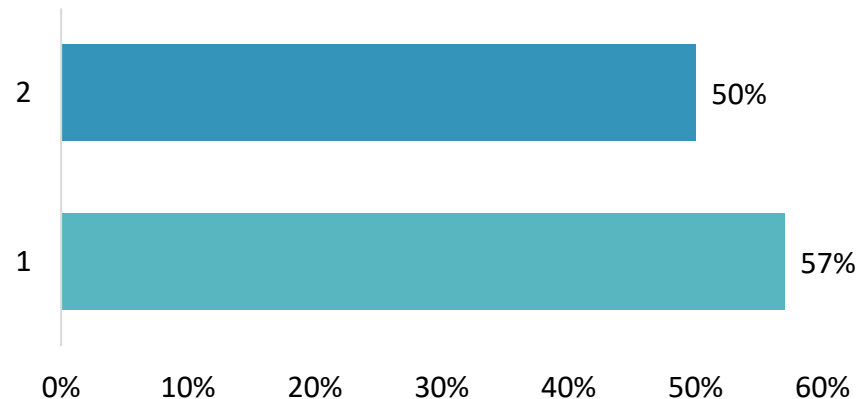
“This POSITIVE urine culture may represent asymptomatic bacteriuria or urinary tract infection. If urinary tract infection is suspected clinically, please call the microbiology laboratory ... for identification and susceptibility results.”

Of 110 positive urine cultures, 76 (69.1%)
represented ASB rather than UTI
Modified reporting, request the release
results in 26.4%

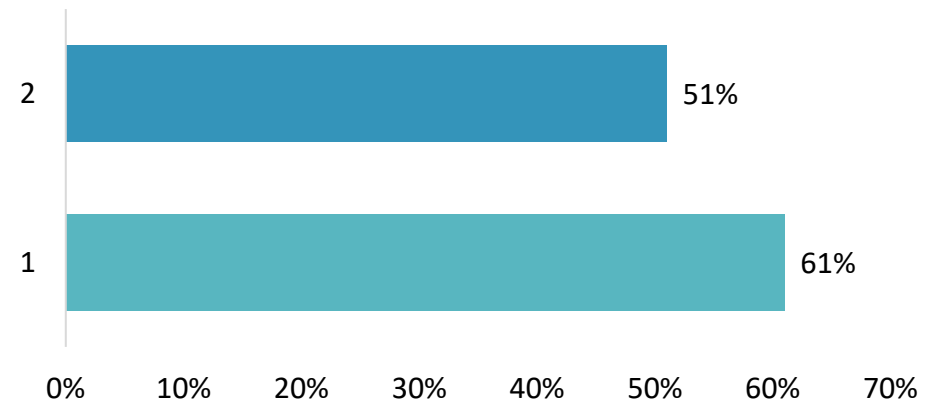


Modified Reporting of Urine Cultures

- 100 patients (1:1) randomized to modified vs standard reporting of positive urine cultures from **catheterized patients**
 - 75% were CA-ASB vs 25% true CA-UTI



- 100 patients (1:1) modified vs standard laboratory reporting of positive urine cultures **NH residents**
 - 62% ASB vs 38% true UTI



- *Providers frequently requested full organism ID and susceptibility in the modified arm (~30%)*

Treatment - Complicated UTI

New classifications of uUTI and cUTI

Old Classifications

Uncomplicated UTI:

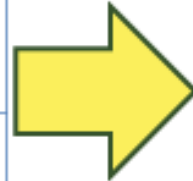
Acute cystitis in afebrile nonpregnant premenopausal women with no diabetes and no urologic abnormalities



Acute Pyelonephritis: Acute kidney infection in women otherwise meeting the definition of uncomplicated UTI above



Complicated UTI: All other UTIs



New Classifications

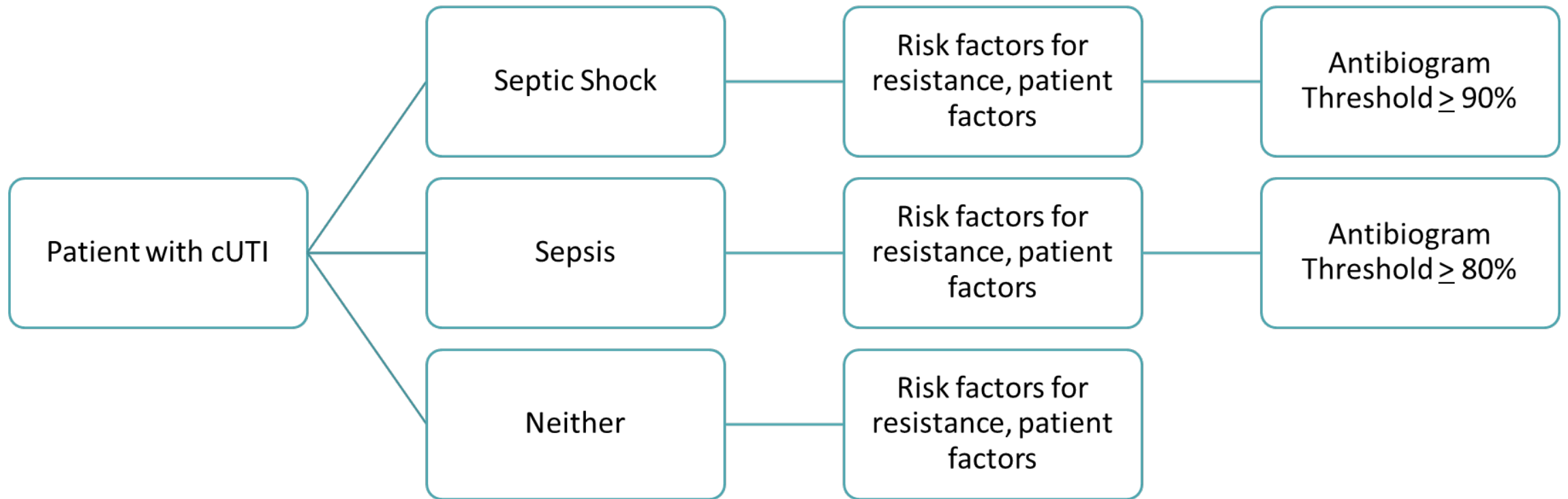
Uncomplicated UTI: Infection confined to the bladder in afebrile women or men

Complicated UTI: infection beyond the bladder in women or men

- Pyelonephritis
- Febrile or bacteremic UTI
- Catheter-associated (CAUTI)
- Prostatitis* (*not covered by these guidelines)



Complicated UTI: The Four Step Approach



Complicated UTIs: Empiric Therapy

	Preferred Agents	Alternative Agents
Sepsis (\pm shock)	Ceftriaxone, cefepime, ceftazidime piperacillin/tazobactam, meropenem, ertapenem, imipenem/cilastatin, fluoroquinolones	Novel beta-lactam/beta-lactamase inhibitors, cefiderocol
Without sepsis, IV route	Ceftriaxone, cefepime, ceftazidime piperacillin/tazobactam, levofloxacin, ciprofloxacin	Carbapenems, novel beta- lactam/beta-lactamase inhibitors aminoglycosides (with another agent),
Without sepsis, PO route	Levofloxacin, ciprofloxacin, TMP/SMX	Oral beta-lactams (amoxicillin/clavulanic acid, oral cephalosporins*)

The novel beta lactam-beta lactamase inhibitors currently include ceftolozane-tazobactam, ceftazidimeavibactam, meropenem-vaborbactam, and imipenem-cilastatin-relebactam

Older aminoglycosides include gentamicin, amikacin, and tobramycin

The fluoroquinolones approved for UTI currently include ciprofloxacin and levofloxacin

*Oral cephalosporins to be discussed later in these slides

Complicated UTIs: Empiric Therapy

Step 1: Severity of Illness

- Distinguish: no sepsis, sepsis, septic shock
- Severity guides initial spectrum and route
- More severe illness → higher need for early active IV therapy
- Sepsis: infection + organ dysfunction (Δ SOFA ≥ 2)
- Septic shock: sepsis + vasopressors + lactate >2 mmol/L

Systemic Inflammatory Response Syndrome (SIRS)

- Temperature $>38.3^{\circ}\text{C}$, or $<36^{\circ}\text{C}$
- Heart Rate >90 bmp
- Respiratory Rate >20 breaths/min
- White blood cell count $>12,000/\text{mm}^3$ or $<4,000/\text{mm}^3$ or $>10\%$ bands

Complicated UTIs: Empiric Therapy

Step 2a: Prior Cultures & Resistance

- Review urine and other cultures from past 3 to 12 months
- Avoid empiric agents with documented resistance
- More recent cultures are more predictive (3 to 6 months)

Step 2b: Prior Antibiotic Exposure

- Avoid empiric fluoroquinolones if used in past 12 months
- Recent exposure to other classes (e.g., β lactams)
 - Recent exposure increases risk of resistance

Step 3: Patient-Specific Factors

- Allergies and previous adverse reactions
- Renal/hepatic function and drug clearance
- Drug–drug interactions, QT risk, *C. difficile* risk
- Pregnancy, immunosuppression, structural abnormalities

Guideline Recommendation

Complicated UTIs: Empiric Therapy

Step 4: Role of the Antibiogram in Sepsis/Septic Shock

- Use local, recent (≤ 12 months) antibiogram data
- Sepsis with shock: target $\geq 90\%$ susceptibility
- Sepsis *without* shock: target $\geq 80\%$ susceptibility
- Non-Septic cUTI
 - Mortality generally $\leq 5\%$ in non-septic cUTI
 - Initial “miss” less impactful on mortality
 - Aggressive broad empiric therapy may drive resistance

Example Hospital							
Gram-negative Antibiogram							
Gram Negative Bacilli	# of Isolates	Gentamicin	Ampicillin-Sulbactam	Cefazolin	Ceftriaxone	Cefepime	Levofloxacin
<i>Acinetobacter baumannii</i> complex	100	79	87			76	
<i>Citrobacter freundii</i> complex	96	87	R	R	59	90	78
<i>Citrobacter koseri</i>	99	100	80	89	91	91	89
<i>Enterobacter cloacae</i> complex	343	97	R	R	59	75	85
<i>Escherichia coli</i>	2,187	90	54	77	87	90	66
<i>Klebsiella aerogenes</i>	198	99	R	R	74	94	88
<i>Klebsiella oxytoca</i>	136	96	54	54	85	94	91

Guideline Recommendation

INSPIRE Trial: Stewardship Prompts for UTI

Multi-center cluster randomized clinical trial

Intervention

- EMR-based stewardship prompts at antibiotic ordering
- Suggested guideline-concordant, narrower-spectrum therapy
- Non-interruptive (no hard stop, no approval required)

Primary Outcome

- Guideline-concordant antibiotic selection for UTI

Key Results

- ~70% vs ~60% (intervention vs control) guideline concordance, statistically significant
- ↓ Broad-spectrum antibiotic use, shift to narrower spectrum agents
- No increase in treatment failure or adverse events

Low-friction CDS nudges → modest but meaningful improvements in prescribing

Complicated UTIs: Definitive Therapy

De-escalate once pathogen and antibiotic susceptibilities (AST) known

Switch from broad empiric to targeted narrow agent

Align route and spectrum with clinical status

Rationale for De-escalation

- Maintains efficacy while minimizing toxicity
- Reduces *C. difficile* infection risk and selection of MDR organisms
- Lower cost, simplified regimens

IV-to-PO Transition

Switch to PO therapy when:

- Clinical improvement
 - Afebrile
 - Hemodynamically Stable
 - Source Control (if needed)
 - Blood cultures negative (if previously positive)
- Tolerates PO intake
- Active oral option available

Bioavailability Matters

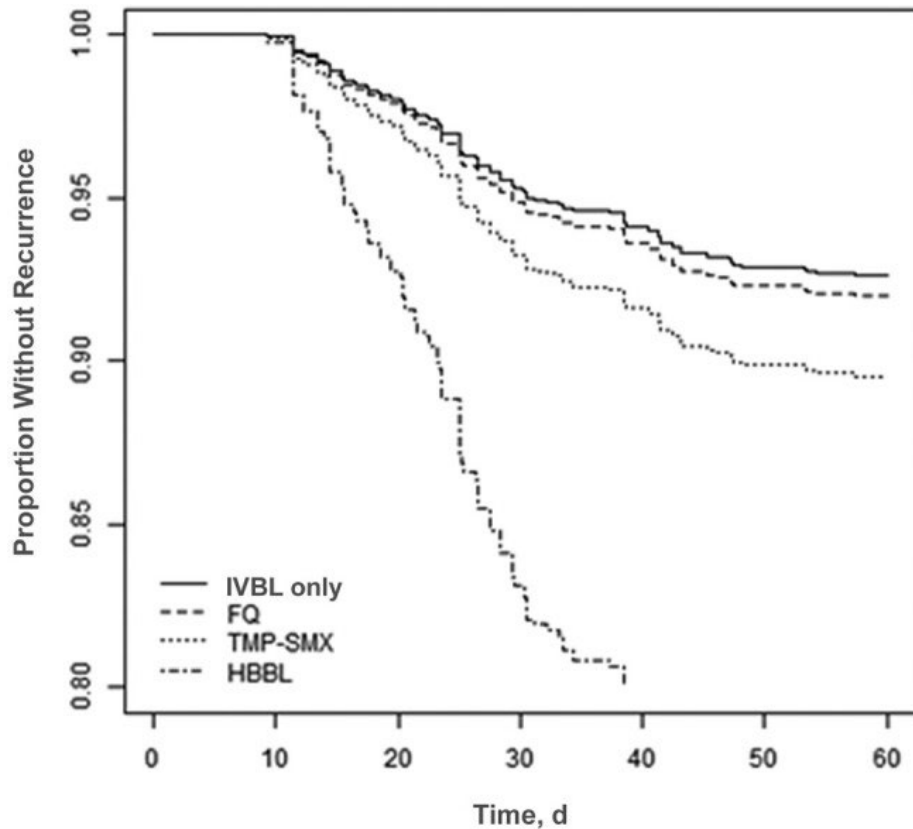
Oral Options for Step-Down Therapy:

- TMP-SMX
- Amoxicillin/clavulanic acid
- Fluoroquinolones (when justified)

Potential benefits:

- Fewer line-related complications (e.g., infections, clots)
- Reduced nursing workload and costs
- Shorter length of stay, improved comfort

Intravenous and Oral Antibiotic Stepdown



Multicenter cohort emulated a 4-arm trial for gram-negative bloodstream infection from a complicated UTI source

- Full-course IV β -lactam (IVBL)
- Oral fluoroquinolone (FQ) step-down
- Oral TMP-SMX step-down
- Oral high-bioavailability β -lactam (HBBL) step-down

No significant difference in 60-day recurrence for FQs or TMP/SMX vs IVBL

HBBLs were associated with \sim 4-fold higher recurrence vs IVBL

- 67% of HBBL regimens were **under-dosed** for bacteremia, likely contributing to failures

Oral β -lactams for IV \rightarrow PO Stepdown

Evidence increasingly supports oral β -lactams as IV \rightarrow PO option for uncomplicated Gram-negative bloodstream infection

Especially with:

- Urinary source
- **Optimized dosing**
- Effective source control

High dose high bioavailability oral β -lactams antibiotics showed no significant difference in recurrence compared to standard dosing

- High-bioavailability oral β -lactams: high-dose cephalexin, amoxicillin/clavulanic acid

Pivmecillinam: Single-arm trial in *E. coli* BSI/UTI showed 88% composite clinical success after 3 days IV + 7 days oral pivmecillinam

Oral Cephalosporins for Gram-Negative BSI from UTI

Multiple observational studies suggest that oral β -lactams, especially cephalosporins, can be an effective stepdown option after initial IV therapy

In several UTI-focused bacteremia cohorts, clinical cure with oral β -lactams (mostly cephalexin, cefuroxime, cefpodoxime) was ~90–98%, not statistically different from FQs/TMP-SMX

Many failures in large datasets appear linked to suboptimal β lactam dosing (low serum levels)

Drug (oral)	Bioavailability / PK	Typical Regimens*
Cephalexin	High (95%); good urinary concentration	1 g Q6H for bacteremic UTI step-down
Cefadroxil	High (90%)	1 g BID; Lack of PK target attainment data
Cefuroxime	Moderate (); good urinary concentration	500 mg BID achieves PK targets for MIC \leq 0.5 mg/L
Cefpodoxime	Moderate (45%); Success when dosed appropriately	400 mg BID (MIC \leq 2 mg/L)
Cefdinir	Low (25%) and <20% excreted unchanged in urine	Higher failure compared to cephalexin

Ceftriaxone as a Surrogate for Oral Cephalosporins

CLSI recommends using cefazolin interpretation for higher generation cephalosporins

Tested 409 consecutive *Enterobacterales* bloodstream isolates from unique patients by disk diffusion:

- Ceftriaxone (IV)
- Cefuroxime, cefdinir, cefpodoxime, cefixime (oral)

Ceftriaxone susceptibility is a reasonable surrogate to infer susceptibility to commonly used higher-generation oral cephalosporins in *Enterobacterales* bloodstream isolates

Organisms	Accuracy of ceftriaxone as surrogate
All <i>Enterobacterales</i>	86–94% prediction for cefuroxime, cefdinir, cefpodoxime, cefixime
Ceftriaxone-susceptible isolates only	92–99% susceptible to each oral agent
<i>E. coli</i>, <i>Klebsiella</i> spp., <i>P. mirabilis</i> group	92–99% concordance across all oral agents

Complicated UTIs: Duration of Therapy

Shorter courses recommended

- Fluoroquinolones: 5–7 days
- Non-FQ agents: 7 days

Supported by multiple RCTs showing non-inferiority

Duration counted from *first effective* day of therapy and clinical improvement

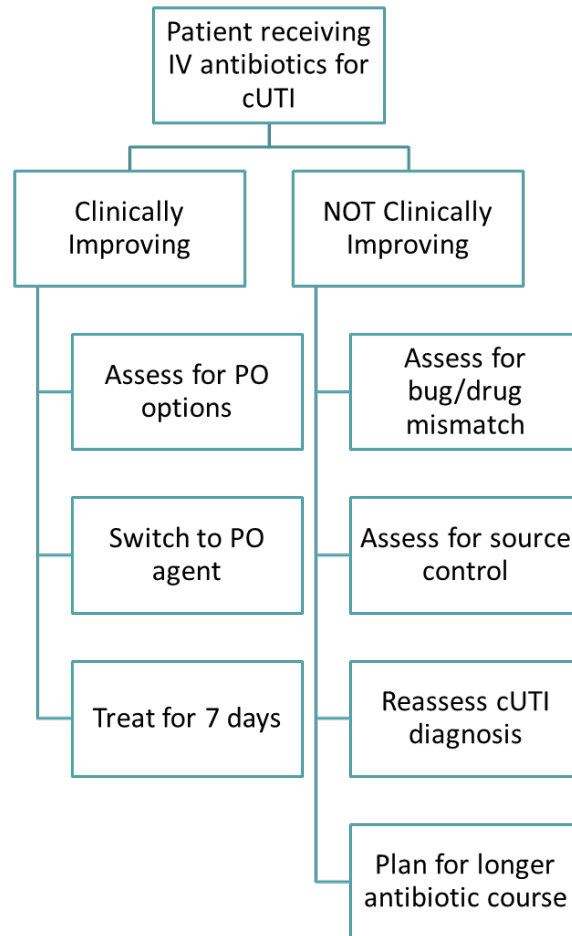
When Longer Courses Are Needed

- Prostatitis
- Poor source control
- Delayed response

Data for short duration mostly excludes:

- Indwelling catheters, severe sepsis, major immunocompromised status
- Abscess, complete obstruction, peri-urologic surgery
- Febrile men (may still need 14 days of therapy)

cUTI Guidelines Take-Home Points



Empirically start based on severity, resistance risk, and patient-specific factors; narrow when cultures return

- Local antibiograms remain critical for patients with sepsis or septic shock

Short-course therapy is standard for most patients

- For most adult cUTI 5 to 7 days are adequate

IV-to-PO switch should be early and intentional

- IV → PO switch is safe when stability and active oral options exist

Stewardship Key Takeaways

Diagnosis drives treatment

Over-testing → over-treatment

UA + cultures in low-risk patients → unnecessary antibiotics, *C. difficile*, resistance

Diagnostic stewardship → high leverage interventions

Right test, right patient, right action

Stop diagnostic momentum before antibiotics

Simple system-based interventions work

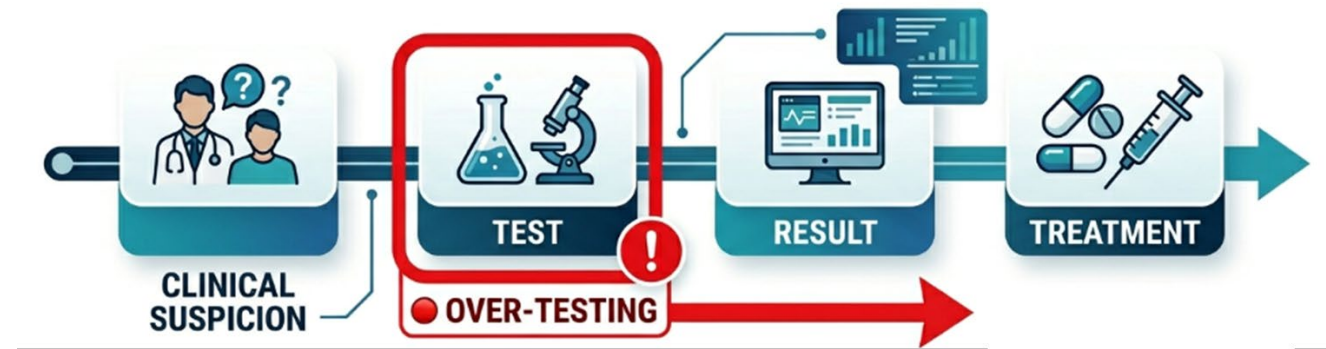
Ordering • Processing • Reporting

↓ cultures, ↓ antibiotics, no harm signal

Optimize treatment

But don't start unnecessarily

Early de-escalation, IV→PO, short courses (5–7 days)



Stewardship-Driven Advances in UTI Diagnosis and Management

Kim Claeys, PharmD, PhD

Associate Professor Infectious Diseases

University Of Maryland School Of Pharmacy

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