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Urinary Tract Infection and Asymptomatic Bacteriuria in Older Adults

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Synopsis

Urinary tract infections (UTIs) are a significant cause of morbidity among older adults; however, antibiotic prescriptions for clinically suspected UTIs are often inappropriate. Healthcare providers frequently struggle to differentiate UTI from asymptomatic bacteriuria, particularly in patients presenting with nonspecific symptoms. Patients with baseline cognitive impairments that limit history-taking can be particularly challenging. Here, we review the epidemiology and pathogenesis of UTI in older adults. We also discuss an approach to the diagnosis and treatment of UTIs, focusing on recognizing patients who would likely benefit from antibiotic treatment and on identifying patients for whom empiric antibiotic therapy should not be given.

Keywords

Older adults; urinary tract infection; asymptomatic bacteriuria

Introduction

Urinary tract infections (UTIs) are responsible for an estimated 7 million office visits, 1 million emergency room visits, and 100,000 hospitalizations each year, and account for 25% of all infections in geriatric patients [1]. Healthcare providers often confuse asymptomatic bacteriuria (ASB), defined as bacteria in the urine without any symptoms, with UTI, and unnecessary antibiotic treatment of ASB in older adults is common [2]. In the United States, the prevalence of antimicrobial resistance in urinary organisms in the community is increasing [3–5]. Colonization with multidrug resistant organisms is high in nursing home

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settings, and these organisms spread to other settings along with the colonized patients [6]. Multi-drug resistant bacteria implicated in UTIs include extended-spectrum beta-lactamase (ESBL) producing organisms, carbapenem-resistant *Enterobactericeae* (CRE), and now colistin-resistant Gram-negative bacilli [7–9]. At the same time, we increasingly recognize that commonly prescribed antibiotics are associated with severe and sometimes life-threatening adverse events [10]. These trends highlight the need for renewed emphasis on antimicrobial stewardship in the treatment of UTIs, including increased recognition and a proper understanding of ASB.

Confusion about several key issues complicates the approach to the spectrum of syndromes included in the broad category of UTI. Particularly among older adults, these issues include:

- Poorly defined clinical criteria to diagnose UTIs
- Reliance on laboratory criteria rather than clinical symptoms to define infection
- Limited guidance regarding the use and interpretation of diagnostic tests
- Challenges for selecting empiric antimicrobial therapy
- Difficulty distinguishing ASB from UTI, particularly in older adults with dementia
- Increased risk of adverse events and drug interactions related to antibiotic use

This review summarizes the epidemiology, microbiology, and pathogenesis of urinary tract infection in older adults, provides clinically-applicable definitions, discusses the approach to diagnostic testing for UTIs in this population, and offers guidance regarding optimal treatment for UTIs in elderly patients when treatment is indicated. We have framed UTI in the older adult as a diagnosis of exclusion throughout. Much of inappropriate antibiotic prescribing for UTIs comes from diagnoses based on nonspecific findings such as leukocytosis, weakness and malaise [11]. Given that the risk of harm in delaying UTI treatment in clinically stable patients is low [12], in general the risk-benefit balance favors a cautious approach to diagnosing and prescribing antibiotics for UTIs when localizing signs and symptoms are not present.

Epidemiology, Microbiology, and Pathogenesis of UTIs

Epidemiology

Among patients older than 65, UTIs cause 15.5% of hospitalizations and 6.2% of deaths attributable to an infectious disease [13]. UTIs are the most common type of infection among institutionalized adults and make up over a third of all infections in this population [14–15]. Estimates suggest the overall incidence of UTIs in elderly men and women is in the range of 1 infection per 14 to 20 person-years (0.05–0.07 infections per person-year) [16–17]. These estimates, however, are based on administrative data that is limited by variations in what practitioners considered to be a UTI and may overestimate the true prevalence of this disease.

Increasing age is itself a risk factor for UTIs. This risk is likely multifactorial, including increasing rates of urinary incontinence and urinary retention, hospitalizations and accompanying urinary catheterizations, long-term medical institutionalization, and immune senescence. Potentially modifiable factors contributing to UTIs include anatomic abnormalities of the urinary tract, particularly those which produce incontinence or urinary retention, (*e.g.*, prostatic hyperplasia), uncontrolled diabetes mellitus, treatment with the sodium-glucose co-transporter 2 inhibitors (*e.g.*, canagliflozin and dapagliflozin), vaginal atrophy in postmenopausal women, sexual intercourse--a risk factor for both men and women--and most critically in the elderly population, urinary catheterization [18–24].

Microbiology

Epidemiologic surveillance of outpatient urine cultures offers important insights into the changing prevalence and antibiotic susceptibilities of specific uropathogens. Among patients over 65 with uncomplicated cystitis, *E. coli* remains the predominant pathogen, causing nearly two-thirds of cases, followed by *Klebsiella oxytoca* (~15% of cases) and *Proteus mirabilis* (~7% of cases); overall, >90% of cases of cystitis in older adults involve gram-negative bacteria [4]. The microbiology of catheter-associated UTI (CAUTI) is more much diverse. In a review of multicenter data on CAUTIs reported to the National Healthcare Safety Network between 2011 and 2014, *E. coli* (still the most common pathogen) made up only 23.9% of cases, while rates of *Candida* spp (17.8%), *Enterococcus* spp (13.8%), and *Pseudomonas aeruginosa* (10.3%) were significantly higher than in uncatheterized patients [25]. These data reflect the organisms associated with urine cultures that met the surveillance definition for CAUTI, which differs from CAUTIs recognized clinically [26].

Colonization and infection with antibiotic-resistant bacteria increases with age, though the degree to which resistance increases varies by antibiotic class, likely reflecting variation in rates of antibiotic prescribing. For example, among female outpatients in 2012, susceptibility to ceftriaxone among urinary isolates was similar between girls aged 0–17 and women over 65 (83.4% and 84.3%), whereas for ciprofloxacin the rates of susceptibility dropped from 95.4% to 75% between those groups [4, 27]. A limitation to these surveillance data is that in the outpatient setting, a significant proportion of women may receive treatment for cystitis without a urine culture. Consequently, antimicrobial resistance patterns in the community may differ somewhat from the results based on surveillance data [28]. In the case of older adults with UTI, particular attention should be paid to any prior history of colonization or infection (including infections other than UTIs) with multidrug-resistant organisms (MDROs), as well the patient's history of antibiotic exposure in the preceding several months. Both prior carriage of MDROs and prior receipt of antimicrobials, the latter producing selective pressure for MDROs, are risk factors for infections with resistant bacteria. Special attention should also be paid to the local susceptibilities of *E. coli*. Because *E. coli* is is responsible for the majority of infections in uncatheterized patients, the resistance profile of this organism in the community, which providers may assess using their local antibiogram, will help inform selection of empiric antibiotics likely to be effective.

Pathogenesis

Several recent genomic sequencing based studies of human urine demonstrate that the urinary tract is not sterile even when urine cultures are negative; instead, the healthy urinary tract is host to a unique community of bacteria and viruses [29–31]. The bladder microbiome of patients with asymptomatic bacteriuria is ecologically distinct from that of healthy patients with negative cultures [32]. Disruption of the urinary microbiota correlates with a number of genitourinary diseases, including urinary urgency and incontinence, chronic prostatitis, and symptom flares in chronic pelvic pain [33–35].

The urinary microbiota may also mediate susceptibility to UTIs [36–37]. In theory, constituents of the healthy urinary microbiome may play a role in preventing UTIs by occupying attachment sites at the genitourinary epithelium, competing for limited nutrients, and limiting the proliferation of uropathogens via bacteriophage infection. Persistent urinary dysbiosis may compromise host defenses and lead to recurrent UTIs much in the same way that persistent disruption of intestinal microbiota predisposes to recurrent *Clostridium difficile* infections. This model challenges the assumption that ASB is necessarily a prelude to symptomatic UTI and further suggests a role for non-antibiotic approaches to managing recurrent UTI. So far, probiotic supplementation has not shown consistent benefit in preventing UTIs, though the quantity and quality of evidence is limited [38].

Bacterial adhesion to the uroepithelium is a critical step in the pathogenesis of UTIs and thus a potential drug target. Cranberry proanthocyanidins inhibit adherence of *E. coli* P-fimbria to uroepithelial cells and have provoked a longstanding interest in the use of various cranberry products for the prevention of UTI. However, multiple investigations on this topic have failed to show a consistent and clinically relevant benefit of cranberries in UTI prevention, and a recent randomized-controlled trial showed no benefit of cranberry supplementation in preventing pyuria plus bacteriuria among older women in a nursing home setting [39–40].

Urinary catheters, the most important risk factor for UTIs, function as portals of entry for bacteria that are not part of the healthy urinary microbiome. Because the catheter serves as a source of continual bacterial immigration into the ecological niche of the bladder, bacteriuria is ubiquitous in catheterized individuals. While antibiotics can render the urine temporarily sterile, colonization invariably recurs days after antibiotic cessation. Because a persistently sterile urine culture is not a realistic goal for the patient with an indwelling urinary catheter, attempting to eliminate bacteriuria in such a patient with repeated antibiotic prescription merely selects for antibiotic-resistant organisms that may cause the patient future harm [41].

Defining Clinical and Laboratory Criteria for UTI

As a clinical descriptor, urinary tract infection encompasses several clinical syndromes including cystitis, pyelonephritis, and renal or perinephric abscess. Any of these conditions may be accompanied by systemic illness (*e.g.* bacteremia and sepsis) and any of them can occur in the context of urinary catheterization, referred to as catheter-associated UTI (CAUTI). Providers' diagnostic uncertainty in differentiating UTI from ASB contributes to antibiotic overprescribing, and bacteriuria is a risk factor for both receipt of antibiotics for UTI and isolation of MDROs in the urine of nursing home residents [42–43]. We propose definitions for ASB—which is generally not a clinical condition that merits treatment in older adults—and for the spectrum of conditions that comprise UTI. We use these definitions to differentiate older adults who are likely to benefit from receiving antibiotics from those who are not (Figure 1). Note that this figure is intended to be used in clinical diagnosis and management of UTI. Thus our criteria for UTI differ from the revised McGeer criteria, which are intended for surveillance for UTI in long term care [44].

ASB is defined as the presence of bacteria in the urine, with or without pyuria, in the absence of clinical symptoms indicative of a UTI. ASB is common in older adults; in one study of nursing home residents, 25–50% of subjects had bacteriuria at any given time [45]. After adjusting for other comorbidities, older adults with ASB do not experience increases in mortality [2, 46]. Antibiotics administered for ASB do not reduce the rates of subsequent complication and paradoxically, may increase the risk for subsequent UTI [47]. Furthermore, unnecessary antibiotic treatment is associated with acquisition of drug-resistant pathogens, *Clostridium difficile* infection, and other drug-related adverse events [47–49]. Guidelines from the Infectious Diseases Society of America recommend treating ASB only in pregnant women or immediately prior to a urologic procedure likely to involve mucosal injury [2].

The diagnosis of UTI requires three components:

- Clinical symptoms of infection localizing to the urinary tract, or nonspecific symptoms of infection in the absence of symptoms suggesting infection elsewhere
- Laboratory evidence of pyuria and bacteriuria
- The absence of another infection or non-infectious process to which the patient's symptoms can be readily attributed

In older adults, accepted clinical criteria include dysuria alone or fever accompanied by frequency, suprapubic pain, gross hematuria, costovertebral angle tenderness, or new or worsening urgency or urinary incontinence [50]. For patients with an indwelling urinary catheter or who had one removed in the previous 48 hours, fever, rigors or delirium alone—all of which are non-specific—or new costovertebral tenderness may herald a CAUTI [50]. Our proposed criteria for UTI and CAUTI, which are intended to guide antibiotic prescribing in clinical practice, differ slightly from the revised McGeer criteria, which were developed for epidemiologic surveillance [44]. Key differences are that the revised McGeer criteria include leukocytosis and acute functional decline with no alternate diagnosis in their definition for CAUTI. Additionally, our criteria do not consider acute prostatic or testicular pain as the diagnostic approach and treatment for prostatitis and epididymorchitis differ from those for cystitis and pyelonephritis.

Determining whether a change in behavior or mental status is present can be particularly challenging, as evinced by inter-observer variability for these criteria among nursing home staff [51]. Fortunately, dysuria is identified reliably. The presence of dysuria appears to be one of the strongest predictors of bacteriuria plus pyuria in nursing home residents, and new dysuria is the most helpful clinical finding in identifying UTI in older adults [52–53].

Other signs and symptoms can be misleading and are often misinterpreted as an indication for urinary testing. Falls are often considered a reason to test a nursing home resident for UTI, but the association of falls and UTI is controversial. A prospective study in five nursing included 397 suspected episodes of UTI and did not find an association between falls and the presence of bacteriuria plus pyuria [54]. Urine turbidity, sediment color and odor do not reliably correlate with the presence of infection and are not in themselves symptoms of UTI; they are, however, associated with antibiotic overprescribing [55–57]. Such changes in urine may suggest a need for increased oral hydration, reflecting a decreased thirst response in older adults, or may be due to their medications (*e.g.*, multivitamins) or diet (*e.g.*, asparagus).

Patients with UTI should demonstrate both pyuria and bacteriuria. Pyuria, which indicates an inflammatory reaction in the urinary tract, is generally defined as a positive leukocyte esterase on urine dipstick or ≥10 white blood cells per high powered field (WBCs/hpf) on urine microscopy, a threshold selected to offer a high negative predictive value for urine culture positivity and clinical UTI [58]. The accepted criteria for bacteriuria is at least 10^5 colony forming units (cfu) per ml of a single organism in the urine of an uncatheterized patient or 10^3 cfu/ml of ≥1 bacterial species in the urine of a patient who is catheterized or who has had a urinary catheter in the preceding 48 hours [2, 24].

Laboratory testing is primarily useful for excluding UTIs. Pyuria is sensitive but not specific for UTI, particularly among catheterized patients, in whom its presence is ubiquitous. Reliance on pyuria alone for the diagnosis of UTI would lead to widespread antibiotic overtreatment, particularly as pyuria accompanies ASB [2, 59]. Indeed, CAUTI is overdiagnosed, with retrospective studies showing that only 30–50% patients given the clinical diagnosis of CAUTI meet standardized criteria for CAUTI treatment [60]. Studies of the diagnostic value of the urinalysis for UTI have shown that it is an effective-rule out test, but that poor specificity limits its value in ruling in UTI [61–62]. In this regard, the clinical utility of the urinalysis for diagnosing UTI is akin to that of the D-dimer for the diagnosis of a pulmonary embolism; a negative result is of great value for patients with all but the highest pretest probabilities of disease, while a positive result is necessary but not sufficient to establish the diagnosis.

We define UTI as a diagnosis that can only be made after a thorough search for other causes to explain the patient’s symptoms and laboratory findings. This third criterion intends to avoid delays in appropriate therapy due to premature diagnosis of UTI and diagnostic closure. This is particularly relevant for older adults, in whom symptoms attributed to UTI are often not specific to the urinary tract (e.g. fever, lethargy and confusion) and may belie infection at another site (*e.g.*, pneumonia), systemic infection (*e.g.*, bacteremia from a non-urinary source), or another etiology entirely (*e.g.*, heart failure exacerbation).

The clinical presentation of UTI in older adults varies. In one multicenter evaluation of clinical features of UTI in nursing home patients, dysuria and change in mentation were two of the most frequently identified characteristics, with the important limitation that in this study UTI was defined by bacteriuria and pyuria alone, without consideration of clinical symptoms [52]. Factors which may complicate the diagnostic impression include urinary catheterization (which can obscure symptoms such as urinary frequency, urgency, or dysuria), baseline urologic comorbidities producing chronic urinary urgency or frequency, and a higher incidence of baseline cognitive impairments (*i.e.*, dementia) which can prevent the patient from effectively conveying their symptoms to the provider. In such cases, a careful history from caregivers, thorough physical examination of the patient, and prudent laboratory testing may help differentiate UTI from other conditions.

For older adults especially, specific and clear criteria to diagnose UTIs are critical. First, recognition of ASB reduces unnecessary antibiotic exposure in a population rendered vulnerable to adverse drug events by comorbid conditions and polypharmacy [63]. Second, attributing clinical changes to a UTI without consideration of alternative diagnoses risks patient harm by delaying recognition and response to other medical problems. For example, a nursing home resident with a chronic indwelling urinary catheter who develops an acute change in mental status may be diagnosed with a UTI based on a urine dipstick showing pyuria. Providers may reflexively prescribe antibiotics, without considering other reasons for a clinical change, such as an acute cardiac event or ischemic stroke. This may delay appropriate interventions and lead to patient harm. Recognizing the high prevalence of ASB and the potential for misdiagnosis of UTIs on the basis of laboratory findings, both AMDA--The Society for Post-Acute Care and Long-Term Care Medicine and the American Geriatrics Society caution against ordering urine cultures in patients without urinary symptoms [64–65].

Quality and Interpretation of Urine Specimen Collection

Obtaining an adequate quality urine sample is frequently the first major barrier to appropriately diagnosing UTI in older adults. Guidelines specific to long-term care residents recommend collecting a mid-stream clean catch urine specimen for urine studies [66]. In reality, such a collection is an often laborious process requiring the patient to possess not only urinary continence but a degree of cognition, coordination, and mobility that many older adults–particularly those who are institutionalized–may lack. For patients who cannot provide such a specimen, recommendations are to place an external condom catheter in men or perform in/out urinary catheterization in women, which can cause significant discomfort. Staff collecting urine specimens may use approaches that are not recommended by guidelines, such as obtaining the urine from a chronic urinary catheter or urine collection bag, both of which become contaminated with bacteria within hours of urinary catheter placement [24]. Finally, the person who interprets the results of urine studies may or may not be the same person who ordered the tests and is most certainly not the person who collected the sample.

Clinical symptoms that localize to the genitourinary tract should prompt testing urine for possible infection (Figure 1). In such patients, the diagnostic test of choice is a urinalysis with reflex to urine culture for specimens with pyuria (≥10 WBCs/hpf or positive leukocyte esterase). The urinalysis has a negative predictive value for growth of bacteria in urine culture approaching 100% [67]. In patients who lack pyuria, attention should be turned away from UTI and toward other diagnostic considerations, except in rare cases where neutropenia or other conditions may prevent pyuria. This algorithmic approach combining the urinalysis and urine culture offers both excellent sensitivity and specificity for UTI, with the reflex criteria averting inappropriate urine culture orders, a primary driver of unnecessary antibiotic prescription in patients with ASB [57–58].

Because of older patients' higher burden of comorbidity and consequent risk of adverse events due to antibiotic therapy, we recommend active monitoring without antibiotics for older adults with possible UTI symptoms who are clinically stable (*i.e.*, no evidence of sepsis) until the results of the urinalysis and reflex culture are available. Active monitoring includes frequent assessment of vital signs for early detection of sepsis, parameters for hydration, and criteria for notifying the physician or other provider if the patient's condition worsens [68]. If a patient spontaneously improves while waiting for the results of urine tests, a positive urine culture likely reflects ASB and the provider should consider other reasons for the patient's symptoms. If the patient deteriorates during a period of active monitoring, then providers should consider empiric antibiotic therapy until culture results become available or, depending on the clinical symptoms, consider other diagnoses. Order sets that support "monitoring off antibiotics" can help standardize active monitoring interventions [68]. When it is necessary to start antibiotics before culture results are known, facility antibiograms should inform selection of empiric treatment, if available.

Urine cultures should not be obtained in older adults unless clinical symptoms suggest a UTI and the accompanying urinalysis demonstrates pyuria (or the patient is neutropenic). Inappropriate ordering of urine cultures is harmful because, just as with a urinalysis, a urine culture does not distinguish between UTI and ASB. Detection of bacteriuria may lead to inappropriate antibiotic therapy, particularly when the patient has a peripheral leukocytosis or when the urine is colonized by a typical or multi-drug resistant uropathogen [11]. In older adults with both pyuria and clinical symptoms consistent with a UTI, we recommend obtaining urine cultures in conjunction with prescribing empiric antibiotics for UTIs. Urine cultures may indicate that the empiric agent should be narrowed or, because the presence of antibiotic-resistant bacteria increases with age [4], that a change to a more broad-spectrum antibiotic may be warranted.

Treatment of UTIs

For patients with a UTI, antibiotics provide symptomatic relief and may help prevent complications such as pyelonephritis, perinephric abscess, and bacteremia. The 2010 Infectious Diseases Society of America guidelines recommend four agents for the treatment of uncomplicated cystitis in women: nitrofurantoin, fosfomycin, pivmecillinam, and, where resistance rates are less than 20%, trimethoprim-sulfamethoxazole [69]. No recommendations have been made for UTI in men or empiric treatment of complicated UTI. When choosing empiric treatment in these settings, the provider should refer to the results of prior urine cultures if any are available. A study done in predominantly older men with UTI caused by MDRO found that prior urine culture results, even those collected as long ago as two years from the index case, were useful at predicting the causative pathogen and its susceptibilities [70].

Currently pivmecillinam is not available in the US. Resistance to trimethoprim-sulfamethoxazole now exceeds 20% nationally among common uropathogens in older adults, emphasizing the importance of local antibiogram data in determining whether this antibiotic remains an appropriate empiric agent in a provider's region of practice [4]. Nitrofurantoin is well-tolerated, and susceptibility of uropathogens to this agent remains high in older adults. However, nitrofurantoin achieves poor levels in tissue and serum and thus is only appropriate in patients who have cystitis without suspicion for upper tract disease. A retrospective study of male veterans with UTI treated with nitrofurantoin showed a clinical cure rate of 77% rate, which is comparable to other agents [71]. Decreased creatinine clearance predicted clinical failure in this study; however, two additional studies in older adults, one limited to women, refuted the concern that nitrofurantoin is less effective in treating UTI in patients with reduced creatinine clearance [72–73]. Particularly in older adults, for whom adverse event profile and collateral damage to the microbiome are important considerations, nitrofurantoin is a good choice for uncomplicated UTIs, including in men with preserved renal function.

Fosfomycin is administered as a single-dose oral packet (sachet) that is mixed with water then consumed. Fosfomycin is effective in the treatment of UTI, but its use is limited by availability, cost, and lack of standardized susceptibility testing. As with nitrofurantoin, fosfomycin has poor tissue penetration precluding its use in patients known or suspected to have upper urinary tract disease. In addition, this agent is one of the few remaining oral agents with reliable activity against ESBL-producing uropathogens, suggesting that its use might be justifiably reserved for people known to have these organisms.

Considered a second-line therapy, tetracycline antibiotics achieve therapeutic levels in urine, are well-tolerated, and may have an emerging role as an oral option for UTIs caused by ESBL-producing and carbapenem-resistant organisms. Most laboratories, however, do not routinely test urinary isolates for susceptibility to tetracyclines. Furthermore, uropathogens that are MDROs may also be resistant to tetracyclines, and only limited clinical data support using tetracyclines to treat UTIs [74–75].

Other second-line therapies for uncomplicated UTIs include fluoroquinolones, aminoglycosides, beta-lactam/beta-lactamase inhibitor combinations and extended-spectrum cephalosporins. While narrow spectrum beta-lactams and first-generation cephalosporins have historically played a minor role in the treatment of uncomplicated UTI due to concerns about inferior efficacy versus other agents, they are effective in treating urinary isolates known to be susceptible [68]. Using fluoroquinolones to treat UTIs has become commonplace, in part due their high oral bioavailability and broad spectrum. In May 2016, however, the Food and Drug Administration (FDA) advised that the risks of these medications generally outweigh their benefits for uncomplicated cystitis when other treatment options are available [10]. Beyond the prevalence of resistant organisms, fluoroquinolones increase the risk of several adverse events to which older adults are particularly vulnerable: QT prolongation, tendonitis and tendon rupture, seizures, delirium and *Clostridium difficile* colitis [49, 76–79]. Susceptibility to aminoglycosides remains high among most uropathogens, but the lack of oral formulations of these drugs, the need to monitor serum drug levels, and the risk of major adverse events including nephrotoxicity, vestibular toxicity and ototoxicity limit the role of this class in treating UTIs outside of the inpatient setting. Beta-lactam/beta-lactamase inhibitor combinations and extended-spectrum cephalosporins are broad-spectrum agents, which may lead to increased collateral damage to the patient's microbiome and selection of ESBL-producing organisms.

For patients with severe or systemic infections arising from the urinary tract, including pyelonephritis or bacteremia, empiric therapy with broad-spectrum agents is appropriate [69]. In these cases, fluoroquinolones, beta-lactam/beta-lactamase inhibitors such as piperacillin-tazobactam, and extended-spectrum cephalosporins represent reasonable choices until culture results permit identification of an appropriate narrow-spectrum agent.

The duration of treatment for acute non-severe UTI is best established in women, for whom the recommended duration of therapy varies by drug from 1 to 5 days [69]. Fosfomycin is given in a single dose, TMP/SMX are given over three days, and nitrofurantoin requires a 5 day course of therapy. Historically, male UTI and CAUTI have been treated with longer (7–14 day) courses of antibiotics. However, no clinical trial has demonstrated the superiority of extended durations of therapy in male UTI or CAUTI versus shorter courses, whereas the harms of unnecessary antibiotic therapy are clear. In older adults, who are particularly susceptible to antibiotic-related adverse events, the risk-benefit calculus of antibiotic treatment favors shorter lengths of therapy. Mounting evidence demonstrates that clinical cure can be effective achieved for CAUTI using a short course of antibiotics (≤7 days) when the catheter is removed if the patient is responding rapidly to initial therapy [80–82]. Similarly, longer lengths of therapy (>7 days) do not prevent recurrent UTIs and instead are associated with increased *C. difficile* infection [18].

Until more data is available, longer duration antibiotic therapy (i.e. 10–14 days) remains reasonable for patients with severe urinary tract disease, including pyelonephritis and perinephric abscess, bacteremia, or need for hospitalization due to unstable clinical condition. However, we have intentionally chosen to avoid the labels “uncomplicated UTI” and “complicated UTI” in this discussion. We find the latter term problematic because it encompasses a heterogeneous group of conditions, some of which lack strong data supporting the need for extended courses of therapy (*e.g.* UTI in men and diabetic women), and others for which extended antibiotic therapy alone may be inadequate (*e.g.* UTI in the setting of urinary obstruction requiring mechanical intervention). Instead, we advocate that UTIs be classified by the extent of urinary tract and systemic involvement, and that potentially complicating factors such as diabetes and urinary obstruction be identified and addressed separately, tailoring the antibiotic duration to the complication in question and the patient’s response to therapy.

Prevention of UTI

Effective approaches to CAUTI prevention in long-term care

Removing indwelling urinary catheters is key to managing CAUTI as this both prevents further bacterial influx into the urinary tract and eliminates the reservoir of bacteria in biofilms that adhere to the catheter. Practically speaking, CAUTI prevention hinges on routine reevaluation of catheterized patients to determine whether they continue to have an indication for an indwelling urinary catheter, as well as identifying and treating the underlying comorbidities necessitating the catheter and replacing indwelling catheters with clean intermittent catheterization when appropriate.

Removing catheters that are no longer necessary is an example of a technical intervention, defined as providing professional development and training in urinary catheter utilization, care, and maintenance. More recently CAUTI prevention efforts have also included a socioadaptive component, specifically encouraging improvements in attitudes and behavior concerning patient safety. Two large-scale studies of CAUTI prevention in acute care and long-term care suggest that interventions that combine both cultural change and technical training can be successful at decreasing CAUTI [83–84].

Ineffective approaches to CAUTI prevention

Long-term indwelling urinary catheters need be exchanged only when clinically indicated (*e.g.* obstructed catheter flow, leakage from around the catheter insertion site, physical defect in the catheter, or CAUTI) rather than routinely, as there is inadequate evidence that the latter practice reduces rates of CAUTI [85]. Attempts to decrease rates of catheter-associated UTI and bacteriuria by coating catheters with antibiotics or antiseptic materials have been largely unsuccessful, with either no or limited reductions in clinical outcome at the expense of increased patient discomfort and higher costs [86]. Systemic antibiotic prophylaxis for patients with long-term urinary catheters does not reduce rates of bacteriuria, CAUTI, or death [85].

Conclusion

UTIs cause significant morbidity and mortality among older adults. Unfortunately, inappropriate or unnecessary antibiotics prescribed to older adults to treat suspected UTI, based on non-specific symptoms or “positive” urine studies also leads to adverse events. We favor an approach to diagnosing UTIs rooted in the recognition of clinical signs and symptoms localizing to the genitourinary tract. Furthermore, we emphasize the value of the urinalysis as an exclusionary rather a confirmatory tools for UTIs. For instances when long-term care residents exhibit non-specific changes, active monitoring including hydration, treating pain and reviewing medications offers the possibility of avoiding unnecessary antibiotics while still assuring residents and their family members that the healthcare team is responding to their concerns. Posting criteria for ordering urine studies, reviewing methods to collect good quality urine specimens, implementing active monitoring order sets and offering clinical decision support all represent systems-based approaches that may help curb inappropriate orders for urine studies and for antibiotics.

Developing technologies, such as colonizing the bladder with non-pathogenic bacteria or using catheters impregnated with bacteriophage cocktails are intriguing, but currently our most important means to prevent UTIs is by identifying and addressing modifiable risk factors. When older adults develop UTIs, providers should give preference to narrow-spectrum agents and short courses of therapy in the majority of cases, with empiric antibiotic selections informed by local antibiogram data. Treatment and overtreatment of UTIs represents a significant proportion of antibiotic prescribing for older adults, driving the proliferation of resistant organisms in the community. Older adults are particularly susceptible to adverse events associated with antibiotic treatment, whereas the harms associated with delays in appropriate antimicrobial therapy for UTI are small for the majority of clinically stable patients. Therefore, providers should take a conservative approach to UTI diagnosis and treatment of, balancing the potential benefit for the individual patient with both the risk of harm to that individual and the provider's duty as an antibiotic steward to protect the health of the larger community.

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Key points

- Differentiating urinary tract infection (UTI) from asymptomatic bacteriuria (ASB) helps health care providers avoid harming older adults with inappropriate antibiotic therapy.
- Testing for UTI should be ordered only when suggestive clinical symptoms are present, as laboratory tests alone cannot differentiate ASB from infection.
- The role of testing for UTI is primarily to exclude the diagnosis. With rare exceptions, treatment for UTI should not be given when a patient has a negative urinalysis or urine culture.
- In a clinically stable older adult with nonspecific symptoms of infection (*e.g.* delirium) but no localizing genitourinary tract symptoms, active monitoring and oral hydration may obviate the need for antibiotics for UTI.

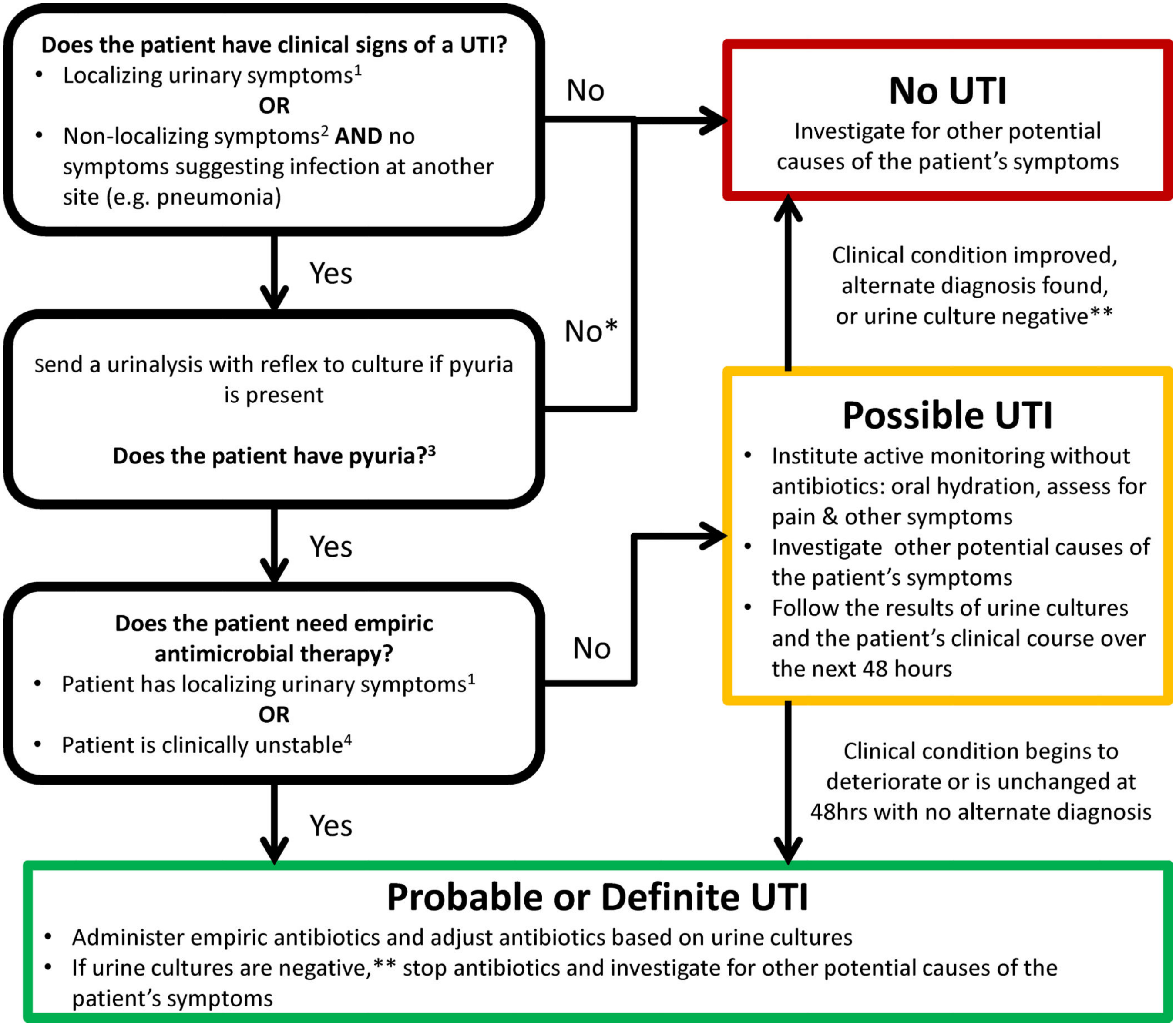

Figure 1. Algorithmic approach to diagnosing ASB and Possible, Probable or Definite UTI

[1]dysuria, frequency, suprapubic pain, gross hematuria, costovertebral angle tenderness, or new or worsening urgency or urinary incontinence

[2]fever, rigors, or clear-cut delirium

[3]>10 WBCs per high powered field on microscopy or positive leukocyte esterase

[4]Fever, sepsis (abnormal SIRS or qSOFA), or acute illness requiring ICU care

*UTI can still be considered in patients with neutropenia or other conditions that might cause the absence of pyuria

**Urine cultures may be negative if obtained after the patient has received antibiotics; in such cases, stop antibiotics given specifically for UTI if the patient's clinical condition is not improving