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Urinary tract infection in older adults

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Abstract

Urinary tract infection and asymptomatic bacteriuria are common in older adults. Unlike in younger adults, distinguishing symptomatic urinary tract infection from asymptomatic bacteriuria is problematic, as older adults, particularly those living in long-term care facilities, are less likely to present with localized genitourinary symptoms. Consensus guidelines have been published to assist clinicians with diagnosis and treatment of urinary tract infection; however, a single evidence-based approach to diagnosis of urinary tract infection does not exist. In the absence of a gold standard definition of urinary tract infection that clinicians agree upon, overtreatment with antibiotics for suspected urinary tract infection remains a significant problem, and leads to a variety of negative consequences including the development of multidrug-resistant organisms. Future studies improving the diagnostic accuracy of urinary tract infections are needed. This review will cover the prevalence, diagnosis and diagnostic challenges, management, and prevention of urinary tract infection and asymptomatic bacteriuria in older adults.

Keywords

aging; asymptomatic bacteriuria; elderly; urinary tract infection

Definitions

Urinary tract infection (UTI) is broadly defined as an infection of the urinary system, and may involve the lower urinary tract or both the lower and upper urinary tracts [1]. The definition of a symptomatic UTI generally requires the presence of urinary tract-specific symptoms in the setting of significant bacteriuria with a quantitative count of $\geq 10^5$ colony forming units of bacteria per milliliter (CFU/ml) in one urine specimen [2,3]. Asymptomatic bacteriuria (ASB) is defined as the presence of bacteria in the urine, without clinical signs or symptoms suggestive of a UTI [2]. Asymptomatic pyuria is defined as the presence of white blood cells in the urine, in the absence of urinary tract specific-symptoms.

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Incidence & prevalence of UTI & ASB

UTI is one of the most commonly diagnosed infections in older adults. It is the most frequently diagnosed infection in long-term care residents, accounting for over a third of all nursing home-associated infections [4,5]. It is second only to respiratory infections in hospitalized patients and community-dwelling adults over the age of 65 years [6,7]. As our population ages, the burden of UTI in older adults is expected to grow, making the need for improvement in diagnostic, management and prevention strategies critical to improving the health of older adults.

Urinary tract infection

The incidence of UTI is higher in women compared with men across all age groups. UTI is frequent in young sexually active women with reported incidence rates ranging from 0.5 to 0.7 per person-year [8], while in young men aged 18–24, the reported incidence of UTI is 0.01 per person-year [9]. The incidence of UTI decreases during middle age but rises in older adults [10–12]. Over 10% of women older than 65 years of age reported having a UTI within the past 12 months [11]. This number increases to almost 30% in women over the age of 85 years [12]. In a large prospective cohort study of post-menopausal women living in the community, the incidence of UTI was 0.07 per person-year and 0.12 per person-year in older women with diabetes [10]. For men aged 65–74 years, the incidence of UTI is estimated to increase to 0.05 per person-year [9]. In both men and women over the age of 85 years, the incidence of UTI increases substantially. A small cohort study in this age group found the incidence of UTI in women to be 0.13 per person-year and 0.08 per person-year in men [13].

Although several estimates exist in the literature, accurately measuring the incidence of UTI in the elderly is challenging since criteria used for diagnosis are not consistent across epidemiologic studies. Furthermore, differentiating UTI from ASB is difficult and misclassification may occur.

Asymptomatic bacteriuria

In contrast to UTI, ASB is more common in older adults than in younger adults. The prevalence increases considerably with age in both men and women. In younger women, the estimated prevalence of ASB is 1–5%, increasing to an estimated 6–16% in women over the age of 65 years [2,14,15]. In women over the age of 80 years living in the community, the incidence is reported to be almost 20% [16]. In long-term care facilities, the prevalence is even higher with estimates in women ranging from 25 to 50% [3]. In young ambulatory men, ASB is uncommon with reported prevalence rates between 0 and 1.5% [17]; however, in men over the age of 80 years, the prevalence is estimated to increase to almost 10% [16]. In aging men residing in long-term care facilities, the prevalence of ASB approaches that of women, ranging from 15 to 35% [3]. The use of urinary catheters predisposes both men and women to ASB. The risk in catheterized older adults ranges from 3 to 10% per day of catheterization, eventually reaching 100% in adults with chronic indwelling catheters [14,18]. Pyuria in combination with bacteriuria is common in both younger and older adults. The prevalence of pyuria in women with bacteriuria is estimated to be 32%, increasing to 90% in elderly men and women [17].

Risk factors associated with UTI

Risk factors for developing symptomatic UTI in the aging population are different to those in younger women. Age-associated changes in immune function, exposure to nosocomial pathogens and an increasing number of comorbidities put the elderly at an increased risk for developing infection [19].

Community-dwelling older adults

Several risk factors associated with UTI in post-menopausal women have been identified, many of which are similar to younger sexually active women. The most consistent and strongest predictor across all age groups is having a history of UTI [10,20,21]. In one study, postmenopausal women with a prior UTI were over four-times more likely to develop a subsequent infection compared with women without a previous diagnosis [20]. In women with over six lifetime UTIs, the risk of developing a subsequent UTI is over seven-times higher than women without a prior history of UTI [10]. Diagnosis of UTI, specifically before the age of 15 years, has also been shown to increase the risk in postmenopausal women, suggesting that genetic factors may predispose certain women to recurrent infections [21].

The relationship between sexual activity and UTI is well established in younger women, although the association in postmenopausal women is not as clear. During intercourse, vaginal bacteria gain access to the urinary tract by colonizing the periurethral mucosa and ascending to the bladder through the urethra [22]. A cohort study in 2008 by Moore *et al.* reported an increase in risk of developing UTI in post-menopausal women who reported intercourse 2 days prior to onset of symptoms (hazard ratio: 3.42; 95% CI: 1.49–7.80). This increased risk of UTI was not demonstrated for those women reporting intercourse 1 day prior (hazard ratio: 1.01; 95% CI: 0.30–3.37) or >2 days prior (hazard ratio: 0.95; 95% CI: 0.52–1.72), making the clinical significance of this finding unclear [23]. Although up to 65% of postmenopausal women report being sexually active [24], most studies have not consistently found intercourse to be a strong predictor for UTI in this population [10,21,23].

Urinary retention and high postvoid residual (PVR) urine has been postulated to be a risk factor for UTI in older adults. In men, prostatic hypertrophy causing obstruction to the normal flow of urine leads to high PVR. High PVR and urinary stasis as a result of chronic obstruction are thought to be important factors for developing UTI and ASB in older men; however, studies evaluating the association in this population are limited. In women, the association between high PVR and UTI has been more thoroughly examined, although data from several studies have yielded conflicting results. A 2011 cohort study of postmenopausal women did not find high PVR (>200 ml) to increase the 1-year risk of UTI in a multivariate analysis, although PVR >200 ml was associated with more frequent urinary symptoms [25].

Institutionalized older adults

Institutionalized adults generally have more functional impairments, higher rates of cognitive deficits and a greater number of medical comorbidities compared with older adults living in the community. All of these characteristics predispose this population to higher rates of ASB and UTI [26]. The most significant risk factors associated with UTI in institutionalized older adults are the presence of a urinary catheter and, similar to community-dwelling older adults, history of prior UTI [3,13,27]. Medical comorbidities, such as stroke and dementia, which may predispose individuals to bowel and bladder incontinence, have been associated with symptomatic UTI and persistent ASB in this population [13,26]. Other predictive factors include disability in activities of daily living and having a history of urinary incontinence [13]. Similar to women in the community, high PVR has not been associated with UTI in nursing home residents [28]. ASB, which is most common in nursing home residents and catheterized adults, has been associated with an increased risk of symptomatic UTI in a few studies [10,29].

Diagnosis of UTI & ASB

Community-dwelling older adults

UTI in healthy older women without a urinary catheter or abnormalities of the genitourinary tract is generally regarded as uncomplicated [30]. Diagnosis follows the same algorithm used in younger patients, requiring the presence of genitourinary symptoms and a positive urine culture. Common urinary symptoms suggestive of cystitis include urgency, frequency, dysuria and supra-pubic tenderness. However, postmenopausal women may also present with nonspecific generalized symptoms, such as lower abdominal pain, back pain, chills and constipation [24].

ASB in women is defined as the presence of two consecutive urine specimens positive for the same bacterial strain in quantities $\geq 10^5$CFU/ml, in the absence of any signs or symptoms of a genitourinary tract infection. For men, ASB is defined as a single voided specimen with one bacterial isolate in quantities $\geq 10^5$ CFU/ml, in the absence of symptoms [2]. For adults with an indwelling urethral, suprapubic or intermittent catheter, ASB is defined as a positive urinary culture for one bacterial isolate in quantities $\geq 10^2$ CFU/ml, in the absence of symptoms [31]. Although ASB is common in older adults, it has not been associated with adverse clinical outcomes, thus routine screening is not recommended [2,32].

Institutionalized older adults & catheterized patients

Similar to other populations, the diagnosis of symptomatic UTI in nursing home residents requires the presence of genitourinary symptoms in the setting of a positive urine culture. In older adults who are cognitively intact, the diagnosis of symptomatic UTI is relatively straightforward. However, nursing home residents often suffer from significant cognitive deficits, impairing their ability to communicate, and chronic genitourinary symptoms (e.g., incontinence, urgency and frequency), which make the diagnosis of symptomatic UTI in this group particularly challenging. Furthermore, when infected, nursing home residents are more likely to present with nonspecific symptoms, such as anorexia, confusion and a decline in functional status [33]; fever may be absent or diminished [19]. In the setting of atypical symptoms, providers are often faced with the challenge of differentiating a symptomatic UTI from other infections or medical conditions. The high prevalence of bacteriuria plus pyuria in this population often leads to the diagnosis of UTI. Although bacteriuria plus pyuria is necessary for diagnosis of a laboratory-confirmed UTI, alone it is not sufficient for making the diagnosis of symptomatic UTI. To date, universally accepted criteria for diagnosing UTI in this population do not exist, making it difficult for providers to distinguish a symptomatic UTI from other conditions in the presence of new nonspecific symptoms.

To aid clinicians in diagnosing symptomatic UTI, several consensus guidelines have been published standardizing definitions for symptomatic UTI in long-term care facilities. In 2001, Loeb *et al.* proposed a set of guidelines aimed to assist providers with clinical decision-making by providing recommendations on the minimum criteria needed for initiation of antibiotics in nursing home residents [34]. The Loeb criteria for diagnosing UTI are outlined in Table 1. In 1991, McGeer *et al.* first developed consensus-based guidelines aimed at standardizing infection definitions for surveillance and research activities in long-term care facilities [35]. Although commonly used by regulating agencies and infection control practitioners for reporting purposes, these consensus definitions, known as the McGeer criteria, were never validated [36]. In 2012, members of the Society for Healthcare Epidemiology of America, assembled to update the current guidelines. Significant changes were made to the definition of UTI for residents with and without a urinary catheter. Most notably, the new definitions require a positive urinary culture in both residents with and

without an indwelling urinary catheter, or the presence of a positive blood and urine culture in residents without localized symptoms of UTI [37]. Table 1 provides a comparison of three published consensus definitions. The diagnostic accuracy of these guidelines has not yet been validated.

Although guidelines proposed by Loeb *et al.* are commonly accepted, applying these criteria to clinical practice in the nursing home population is challenging and the overuse of antibiotics remains a significant problem [36]. A major challenge clinicians face when diagnosing UTI is the relative low frequency of localized genitourinary symptoms (i.e., dysuria, frequency and urgency) found in nursing home residents, many of which are necessary components of the Loeb criteria. In a recent study of nursing home residents with advanced dementia, mental status change was the most common reason for suspected UTI, accounting for over 40% of cases; localized genitourinary symptoms were infrequent. Dysuria was responsible for only 3.8% of suspected cases, urinary frequency for 1.5% of cases, and no suspected cases of UTI were due to urgency or suprapubic pain. In this study, 85% of suspected UTIs did not meet criteria for antimicrobial initiation; however, most individuals (75%) were treated with antibiotics [38]. This study illustrates that, although criteria exist for assisting clinicians with diagnosis and treatment of UTI, providers caring for this population may be hesitant to follow them. Furthermore, it highlights the overall low prevalence of typical genitourinary symptoms in severely demented patients with suspected UTI. Further studies are needed to improve and test current clinical criteria used for symptomatic UTI diagnosis, specifically in a population that is often unable to verbalize genitourinary symptoms.

In 2007, a cohort study in nursing home residents attempted to identify clinical features that were predictive of bacteriuria plus pyuria. Although bacteriuria plus pyuria alone is not diagnostic of a symptomatic UTI, their presence signifies a host inflammatory response in the presence of a microbial pathogen, both of which are a necessary components to the diagnosis of UTI. The most commonly reported clinical features for suspected UTI in this cohort were change in mental status (39%), change in behavior (19%), change in character of the urine (i.e., gross hematuria and change in the color or odor of urine; 15.5%), fever or chills (12.8%) and change in gait or a fall (8.8%) [39]. Although change in mental status and change in behavior are commonly reported by providers, only three measures of mental status (i.e., periods of altered perception, disorganized speech and lethargy) and one measure of behavior (i.e., resists care) have been shown to be reliably assessed by providers caring for nursing home residents [40]. In a multivariable analysis, change in mental status, dysuria and change in character of the urine were significantly associated with the outcome of bacteriuria plus pyuria. Dysuria alone predicted 39% of cases with confirmed bacteriuria plus pyuria; however, in combination with either change in mental status or change in character of the urine, the predicted probability increased to 63% [39]. This predicted probability is higher than the Loeb criteria, which had a positive predictive value of 57% for detecting bacteriuria plus pyuria [41]. When all three clinical features were present, the predicted probability increased to 100%, but all three clinical features were only present in four episodes of suspected UTI. This suggests that a combination of nonspecific and urinary tract-specific symptoms (e.g., change in mental status, change in character of the urine and dysuria) may be useful in clinically assessing nursing home residents with UTI [39,41]. Nonspecific symptoms, when present alone, however, have not been shown to correlate with bacteriuria [42]. Future prospective cohort studies validating the proposed combination of clinical features in diagnosing symptomatic UTI in older adults are needed. Falls are common in older adults and often prompt empiric antibiotic use for suspected UTI. Although falls have been previously associated with UTI in few studies, a recent report found that 80% of fall episodes were not associated with bacteriuria plus pyuria [43,44].

The diagnosis of UTI remains a significant diagnostic dilemma for clinicians caring for older adults. Fever and localized urinary symptoms should still be the initial trigger for UTI evaluation. According to the Infectious Disease Society of America guidelines, the minimum laboratory evaluation for suspected UTI should include urinalysis for determination of leukocyte esterase and nitrite level by use of dipstick, and a microscopic examination for white blood cells. If the urinary dipstick is negative for leukocyte esterase and nitrite in a nursing home resident, the negative predictive value is 100% and further evaluation can be halted [45]. If pyuria or a positive leukocyte esterase or nitrite is present, urine culture should be obtained and, if positive, antibiotics for suspected UTI should be considered [33]. Figure 1 represents a modification by the authors of the revised McGeer criteria, which can be used by clinicians as a guide for clinical management. In the revised figure, we incorporate the use of urinary dipstick for leukocyte esterase and nitrite testing as part of the initial evaluation for suspected UTI as per the Infectious Disease Society of America guidelines [33]. In addition, we expanded the definition of symptomatic UTI to include a combination of urinary-specific symptoms and -nonspecific symptoms (e.g., change in mental status or change in character of the urine), as this has been shown to predict bacteriuria plus pyuria in nursing home residents [39]. The modifications present in Figure 1, however, have not been validated. Future prospective studies are needed to validate this algorithm for use in diagnosis of UTI.

Management of UTI In older patients

Microbiology UTI & ASB

The most common organism responsible for causing UTI and ASB in both community and healthcare settings is *Escherichia coli*, followed by other *Enterobacteraciae*, such as *Proteus mirabilis*, *Klebsiella* and *Providentia* species. Gram-positive organisms, such as methicillin-resistant *Staphylococcus aureus* and *Enterococcus*, are less common overall, but are seen with increasing frequency in healthcare settings and in adults with chronic indwelling catheters [46,47].

Treatment guidelines for UTI & ASB

UTI is the most common indication for antibiotic prescriptions in older adults. Previous studies have demonstrated 40–75% of antimicrobial use is inappropriate, particularly in the healthcare setting [38,48]. Over utilization of antibiotics leads to negative consequences including development of multidrug resistant organisms, unwanted side effects (such as *Clostridium difficile* infection) and high healthcare costs. Differentiating symptomatic UTI from ASB remains particularly challenging and treatment of ASB remains a common reason antimicrobials are prescribed.

Treatment for uncomplicated UTI in older adults is similar to younger women. The International Clinical Practice Guidelines, updated in 2010 by the Infectious Disease Society of America and the European Society for Microbiology and Infectious Diseases, recommend nitrofurantoin monohydrate/macrocrystals 100 mg twice daily for 5 days, or trimethoprim–sulfamethoxazole 160/800 mg twice daily for 3 days, if local resistance rates do not exceed 20% [30]. *E. coli* has low resistance rates to nitrofurantoin; however, other *Enterobacteraciae* species, which are more common in older adults, may have intrinsic resistance to nitrofurantoin. In addition, nitrofurantoin is contraindicated in patients with chronic kidney disease, which is more prevalent in older adults. Therefore, trimethoprim–sulfamethoxazole should be the preferred empiric oral option for treatment of clinically suspected UTI in older adults. Local resistance rates, when available, should still primarily influence clinicians empiric antibiotic choices. Fluoroquinolones are among the most

prescribed antibiotics for UTI, but resistance to these antimicrobials is high and they should only be used if sensitivity testing is performed [47].

Several randomized controlled studies have shown no benefit to morbidity or mortality with treatment of bacteriuria with or without pyuria in older adults [32,49]. The current guidelines do not recommend routine screening for ASB for the following groups of older adults: individuals living in the community; institutionalized adults; or patients with an indwelling urinary catheter. Treatment of ASB is only recommended in older adults prior to transurethral resection of the prostate and any urologic procedures for which mucosal bleeding is anticipated [2].

Prevention of UTI

Prevention of UTI in older adults is an important issue, as overuse of antibiotics in this population remains high. Although many studies have focused on prevention of symptomatic UTI, prevention of ASB may also lead to a decrease in antibiotic use, particularly in the nursing home setting.

Community & institutionalized older adults

Prevention strategies for recurrent UTI in postmenopausal women have been studied and include use of antibiotic prophylaxis and nonantimicrobial therapies, such as estrogen replacement therapy and cranberry formulations. Estrogen is thought to play an important role in maintaining a low vaginal pH in pre-menopausal women. As estrogen levels decline in postmenopausal women, the vaginal flora changes and lactobacilli, the predominant flora in younger women, are often absent. This leads to an increase in vaginal pH and promotes colonization of the vagina with uropathogens, such as *E.coli* [50]. Intravaginal estrogen replacement has been shown in a few small studies to reduce the recurrence of UTI in postmenopausal women [51,52], although oral estrogen has not [20,53]. A recent Cochrane review concluded that vaginal estrogen that has potential benefits in postmenopausal women with recurrent UTI and symptoms of vaginal atrophy, although the evidence to support this recommendation is limited [54].

An oral lactobacilli formulation has been tested as a prevention strategy in postmenopausal women with recurrent UTI. The hypothesis was that oral lactobacilli may repopulate the vagina with premenopausal vaginal flora, thereby preventing UTI. However, a randomized control trial evaluating the efficacy of oral lactobacilli found oral lactobacilli to be inferior to antibiotics in preventing recurrent UTIs. Furthermore, they did not find evidence of lactobacilli on vaginal swabs, suggesting that therapy did not restore lactobacilli to the vaginal flora. However, they did find a high rate of antibiotic-resistant isolates (>95%) after 1 month in women taking oral antibiotics [55]. Intravaginal lactobacilli in premenopausal women have been shown to increase vaginal colonization with lactobacilli and reduce the rate of recurrent UTI by almost 50% (relative risk: 0.5; 95% CI: 0.2–1.2), but these findings were not statistically significant. The effect of intravaginal lactobacilli in post-menopausal women is unknown and warrants further study [56].

Cranberry formulations are another nonantimicrobial therapy, which have been used for prevention of UTI in older adults. Cranberry proanthocyanidin (PAC) is the active ingredient in cranberry that inhibits adherence of P-fimbriated *E.coli* to uroepithelial cells [57]. A study by Avorn *et al.* demonstrated that among women living in nursing homes and assisted living facilities, 10 ounces (300 ml) of cranberry juice cocktail reduced bacteriuria plus pyuria at 6 months of follow-up [58]. A major limitation of this study was that participants in the placebo arm of the trial had a higher rate of previous UTI [59]. This study concluded that 10 ounces of cranberry juice cocktail, which contains 36 mg of PAC, may be

effective at reducing bacteriuria plus pyuria. However, subsequent studies in older adults with cranberry products (e.g., juice, capsules or tablets) have had conflicting results. Therefore, there is limited evidence to suggest use of cranberry products in prevention of symptomatic UTI [60]. Two major limitations of published studies with cranberry products are that older adults have been unable to ingest the necessary amount of cranberry juice cocktail; or capsules/tablets have not contained the necessary 36 mg of PAC to show a potential benefit. Future studies should test cranberry products with at least 36 mg of PAC to determine whether they are effective at preventing bacteriuria plus pyuria and UTI in older adults.

Catheterized patients

Catheter-associated bacteriuria is the most common infection in both hospitals and long-term care facilities [31,61]. Prevention of catheter-associated UTI (CA-UTI) has recently become a top priority in many institutions, as the Centers for Medicare and Medicaid Services are no longer reimbursing hospitals for healthcare-acquired CA-UTI. Development of prevention strategies, including aseptic insertion of urinary catheters, minimizing use of catheters and minimizing duration of catheter use, has led to a decrease in the incidence of CA-UTI [18]. In adults who require catheterization, the use of antimicrobial-coated catheters may delay bacterial colonization and thus decreases the incidence of CA-UTI. A recently published, randomized controlled trial evaluated the use of two antibiotic-coated catheters (silver alloy-coated catheter and nitrofural-impregnated catheter) in reducing the incidence of symptomatic CA-UTI in patients requiring short-term catheter use. No benefit was found with either catheter in prevention of symptomatic UTI. However, use of the nitrofural-impregnated catheter did reduce the incidence of bacteriuria. This finding may have important implications, as overutilization of antibiotics for treating ASB remains a significant problem [62].

Conclusion & future perspective

UTI and ASB are highly prevalent in older adults. Overutilization of antibiotics for ASB remains a significant problem, especially in long-term care facilities. A major challenge facing clinicians is distinguishing symptomatic UTI from ASB. Surveillance definitions for UTI in long-term care facilities have recently been updated, but the clinical diagnostic dilemma of defining UTI and identifying which patients to treat with antibiotics persists. Developing an evidence-based approach for diagnosing UTI remains a top priority. Future studies validating combinations of clinical features to predict bacteriuria plus pyuria should be conducted and serve as the foundation for an evidence-based clinical definition of UTI. Controlled treatment studies assessing health outcomes after antibiotic use for suspected UTI in older adults who present with nonspecific symptoms could help determine cause–effect of antibiotic treatment. Finally, prevention of both UTI and ASB remains important and future controlled trials evaluating nonantimicrobial therapies, such as cranberry capsules and lactobacilli, are needed.

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Executive summary

Challenges associated with diagnosing urinary tract infection in older adults

- Urinary tract infection (UTI) and asymptomatic bacteriuria are among the most commonly diagnosed infections in older adults and are the most common reason for antimicrobial prescriptions in nursing home residents.
- Older patients often present with atypical symptoms, making the differentiation of asymptomatic bacteriuria from symptomatic UTI challenging.
- Current guidelines developed to assist providers with diagnosis and treatment of UTI in nursing home residents are not routinely used by providers caring for this population.
- Overutilization of antimicrobials for suspected UTI remains a significant problem and leads to a variety of negative consequences including development of multidrug-resistant organisms.

Future perspective

- Development of an evidence-based definition for UTI is needed.
- Prevention strategies with nonantimicrobial therapies, such as lactobacilli and cranberry formulations, may prevent asymptomatic bacteriuria and, thus, lead to a decrease in antibiotic prescriptions for suspected UTIs.

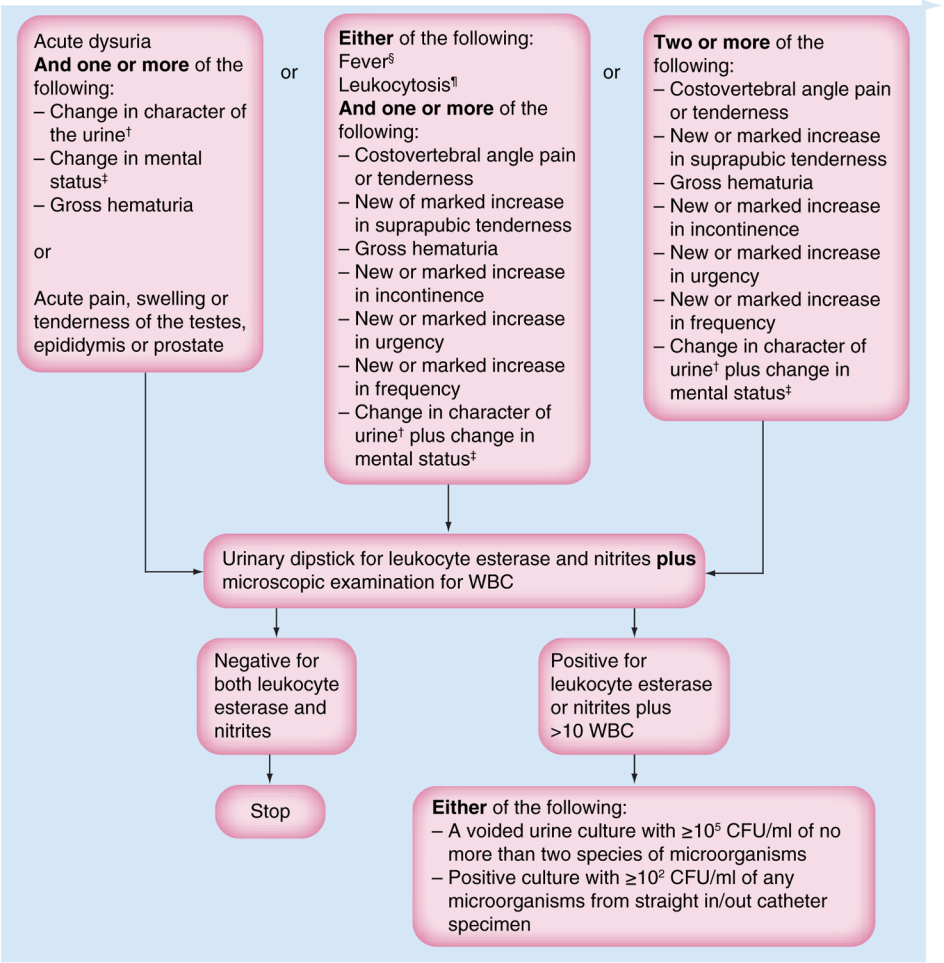

Figure 1. Diagnostic algorithm for urinary tract infection in long-term care facilities in residents without an indwelling catheter

†Change in color or odor of urine.

‡Change in level of consciousness, periods of altered perception, disorganized speech or lethargy.

§Single temperature ≥37.8°C (>100°F) or >37.2°C (>99°F) on repeated occasions, or an increase of >1.1°C (>2°C) over baseline.

¶Leukocytosis: >14,000 cells/mm^3 or left shift >6% or 1500 bands/mm^3. WBC: White blood cell.

Table 1

Comparison of consensus criteria for diagnosis of symptomatic urinary tract infection in residents with and without an indwelling urinary catheter.

SHEA/CDC 2012 (revised McGeer criteria) [37]	McGeer criteria 1991† [35]	Loeb criteria [34]
Without an indwelling urinary catheter		
Swelling or tenderness of the testes, epididymis or prostate or: Fever or leukocytosis and at least one of the following or: • Acute costovertebral angle pain or tenderness • Suprapubic pain • Gross hematuria • New or marked increase in incontinence • New or marked increase in urgency or frequency In the absence of fever and leukocytosis at least two of the following: • Suprapubic pain • Gross hematuria • New or marked increase in incontinence • New or marked increase in urgency • New or marked increase in frequency Plus positive urine culture§	Three of the following criteria: • Fever ≥38°C or chills • New or increased burning pain on urination, frequency, or urgency • New flank or suprapubic pain or tenderness • Change in character of urine‡ • Worsening of mental or functional status (includes new or increased incontinence)	Acute dysuria alone or: Fever (>37.9° or 1.5°C increase in baseline) plus one of the following: • New or worsening urgency • Frequency • Suprapubic pain • Gross hematuria • Costovertebral angle tenderness • Urinary incontinence
With an indwelling urinary catheter		
One of the following criteria: • Fever, rigors or new-onset hypotension • Acute change in mental status or acute functional decline and leukocytosis • New-onset suprapubic pain or costovertebral angle pain or tenderness • Purulent discharge from around the catheter or acute pain, swelling or tenderness of the testes, epididymis or prostate Plus positive urine culture¶	Two of the following criteria: • Fever ≥38°C or chills • New flank or suprapubic pain or tenderness • Change in character of urine‡ • Worsening of mental or functional status	At least one of the following: • Fever (>37.9° or 1.5°C increase in baseline) • New costovertebral tenderness • Rigors (shaking chills) • New onset of delirium

†Urine culture results are NOT included in the McGeer criteria.

‡Change in character may be clinical (e.g., new bloody urine, foul smell or amount of sediment) or as reported by the laboratory (new pyuria or microscopic hematuria). For laboratory changes, a previous urinalysis must have been negative.

§At least 10^5 CFU/ml of no more than two species of microorganisms in a voided urine sample, or at least 10^2 CFU/ml of any number of organisms in a specimen collected by an in/out catheter.

¶At least 10^5 CFU/ml of any organism(s).

SHEA: Society for Healthcare Epidemiology of America.