Does This Woman Have an Acute Uncomplicated Urinary Tract Infection?

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Context Symptoms suggestive of acute urinary tract infection (UTI) constitute one of the most common reasons for women to visit clinicians. Although the clinical encounter typically involves taking a history and performing a physical examination, the diagnostic accuracy of the clinical assessment for UTI remains uncertain.

Objective To review the accuracy and precision of history taking and physical examination for the diagnosis of UTI in women.

Data Sources We conducted a MEDLINE search for articles published from 1966 through September 2001 and manually reviewed bibliographies, 3 commonly used clinical skills textbooks, and contacted experts in the field.

Study Selection Studies were included if they contained original data on the accuracy or precision of history or physical examination for diagnosing acute uncomplicated UTI in women. One author initially screened titles and abstracts found by our search. Nine of 464 identified studies met inclusion criteria.

Data Extraction Two authors independently abstracted data from the included studies. Disagreements were resolved by discussion and consensus with a third author.

Data Synthesis Four symptoms and 1 sign significantly increased the probability of UTI: dysuria (summary positive likelihood ratio [LR], 1.5; 95% confidence interval [CI], 1.2-2.0), frequency (LR, 1.8; 95% CI, 1.1-3.0), hematuria (LR, 2.0; 95% CI, 1.3-2.9), back pain (LR, 1.6; 95% CI, 1.2-2.1), and costovertebral angle tenderness (LR, 1.7; 95% CI, 1.1-2.5). Four symptoms and 1 sign significantly decreased the probability of UTI: absence of dysuria (summary negative LR, 0.5; 95% CI, 0.3-0.7), absence of back pain (LR, 0.8; 95% CI, 0.7-0.9), history of vaginal discharge (LR, 0.3; 95% CI, 0.1-0.9), history of vaginal irritation (LR, 0.2; 95% CI, 0.1-0.9), and vaginal discharge on examination (LR, 0.7; 95% CI, 0.5-0.9). Of all individual diagnostic signs and symptoms, the 2 most powerful were history of vaginal discharge and history of vaginal irritation, which significantly decreased the likelihood of UTI when present (LRs, 0.3 and 0.2, respectively). One study examined combinations of symptoms, and the resulting LRs were more powerful (24.6 for the combination of dysuria and frequency but no vaginal discharge or irritation). One study of patients with recurrent UTI found that self-diagnosis significantly increased the probability of UTI (LR, 4.0).

Conclusions In women who present with 1 or more symptoms of UTI, the probability of infection is approximately 50%. Specific combinations of symptoms (eg, dysuria and frequency without vaginal discharge or irritation) raise the probability of UTI to more than 90%, effectively ruling in the diagnosis based on history alone. In contrast, history taking, physical examination, and dipstick urinalysis are not able to reliably lower the posttest probability of disease to a level where a UTI can be ruled out when a patient presents with 1 or more symptoms.

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CLINICAL SCENARIOS

A 24-year-old healthy woman calls her primary care physician complaining of a burning pain when urinating and increased urinary frequency for several hours. She has had 2 prior urinary tract infections (UTIs), and this episode seems "just like the other ones." She is sexually active with one partner and uses a condom with spermicide. She denies fever, back pain, nausea, vomiting, vaginal discharge, and hematuria.

A 20-year-old woman presents to your office complaining of urinary frequency, burning on urination, and vaginal discharge. She states that she has had occasional fevers and chills but denies nausea, vomiting, and back pain. She is sexually active with one partner, takes oral contraceptive pills, and intermittently uses condoms. Physical examination shows her to be in mild discomfort and febrile but without tenderness in her costovertebral areas. Pelvic examination demonstrates no vaginal lesions or rashes, minimal white vaginal discharge, and no cervicitis. Her dipstick urinalysis result is negative for leukocyte esterase, nitrite, and blood.

Why Is This an Important Question to Answer With a Clinical Examination?

Acute uncomplicated UTIs are common among women, accounting for more than 7 million office visits annually in the United States[1] and affecting

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half of all women at least once during their lifetime.[2] A recent study of sexually active young women found the incidence of cystitis to be 0.5% to 0.7% per year.[3] In aggregate, the direct costs of these infections have been estimated to be $1.6 billion annually in the United States.[4]

One might anticipate that the management of acute uncomplicated UTI would be relatively uniform because the causative agents and in vitro susceptibilities are known, and therapeutic responses to antimicrobials have been studied carefully.[2,5-7] Unfortunately, the evaluation and treatment of acute uncomplicated UTI in women vary substantially among physicians,[8] likely reflecting the limitations of routine diagnostic assessments. If done carefully, however, the history taking and physical examination can likely be used in the initial evaluation of patients suspected of having an acute uncomplicated UTI and can guide the selection of additional diagnostic and therapeutic strategies.[2,7]

Definitions

Several types of UTI are possible, described by their location: urethritis, cystitis, pyelonephritis, and perinephric abscess. The usual reference standard for diagnosing UTI is the presence of "significant" bacteria in a clean-catch or catheterized urine specimen, most commonly defined as the isolation of at least 10^5 colony-forming units (CFU) per milliliter of a single uropathogen.[2] In women who present with symptoms of cystitis or urethritis (lower UTI), it has been suggested that the best diagnostic criterion for clean-catch urine is the isolation of uropathogens in concentrations as low as at least 10^2 CFU/mL.[9]

Uncomplicated UTIs occur in individuals who have a normal urinary tract system. A UTI in an individual with a functional or anatomic abnormality of the urinary tract (including a history of polycystic renal disease, nephrolithiasis, neurogenic bladder, diabetes mellitus, immunosuppression, pregnancy, indwelling urinary catheter, or recent urinary tract instrumentation) is considered complicated and may have a higher risk of treatment failure.[10] Differentiating between these types of UTIs is important because uncomplicated infections are usually cured with simple antimicrobial regimens.[10]

Previous studies have shown that the prevalence of asymptomatic bacteriuria (significant bacteriuria without symptoms of UTI) in women of reproductive age is approximately 5%.[11,12] This value represents the pretest probability of disease (the probability of UTI before any diagnostic tests are applied). Several historical features, symptoms, and signs have been associated with acute UTI and may be useful as diagnostic tests, allowing the clinician to estimate the probability of UTI in a patient after taking a history and performing a physical examination (posttest probability). Historical features such as a previous history of UTI, recent sexual activity, or contraceptive use identify individuals at greater risk of developing a UTI. Symptoms of an acute infection include burning or pain on urination (*dysuria*), frequent voiding of small volumes of urine (*frequency*), the urge to void immediately (*urgency*), and the presence of blood in the urine (*hematuria*). Discomfort in the lower abdominal area is also consistent with a UTI. In contrast, patients who report vaginal discharge or irritation are less likely to have a UTI and more likely to have vaginitis or cervicitis. The presence of fever and suprapubic or costovertebral angle tenderness may indicate infection of the upper urinary tract.

Differential Diagnoses

Vaginal infections (eg, *Gardnerella*, *Candida albicans*, *Trichomonas*), sexually transmitted diseases that may lead to pelvic inflammatory disease (eg, *Chlamydia trachomatis*, *Neisseria gonorrhoeae*), and other sexually transmitted diseases (eg, herpes simplex virus) that may mimic symptoms of UTI are considered separate from UTIs. Reasons for this include the fact that they are caused by different microbes; limited to female genital structures with a unique set of complications if untreated; and require different forms of treatment.[13] Differentiating between sexually transmitted diseases, vaginal infections, and UTIs can be difficult because symptoms and signs commonly overlap.[13]

METHODS

We searched the English-language medical literature to determine the accuracy and precision of the clinical examination in women suspected of having an acute UTI. We searched MEDLINE for articles from 1966 through September 2001 with a search strategy similar to that used by other authors in this series.[14] Search terms included *urinary tract infection*, *diagnostic tests*, *physical examination*, and *sensitivity and specificity*. (The complete search strategy is available from the authors on request.) This computerized search was supplemented with a manual review of the bibliographies of all identified articles, additional "core" articles (identified a priori as articles used to develop a recent guideline for treating acute uncomplicated UTI in women), 3 commonly used clinical skills textbooks,[15-17] and contact with experts in the field. One of the authors (B.K.N.) initially screened the titles and abstracts of the search results. Two of the authors (S.B. and B.K.N.) then independently reviewed and abstracted data from articles identified as relevant.

We included studies in our review if they contained original data on the accuracy or precision of the history and/or physical examination in diagnosing acute uncomplicated UTI in healthy women. Articles were excluded if they evaluated infants, children or adolescents, pregnant women, nursing home patients, or patients with complicated UTI; or contained insufficient or incomplete data to allow calculation of likelihood ratios (LRs) for signs or symptoms of acute UTI.

We also chose to include articles on the dipstick test in this analysis because it is commonly used in the clinical setting and provides an immediate result that can be incorporated with other el-

ements of the initial clinical assessment. During our search, we discovered that a previous systematic review evaluated the diagnostic accuracy of the dipstick test.[18] Since this was a high-quality review (meeting all 6 criteria of a previously published guideline for evaluating systematic reviews),[19] we chose to use the information regarding the accuracy of the dipstick test synthesized in that article.

Quality Assessment of Included Articles

The methodological quality of the included articles was assessed independently by 2 authors (S.B. and B.K.N.) using criteria adapted from other authors in this series.[14,20] Disagreements were resolved by a third author (S.S.) Level I studies included those with an independent blind comparison of signs or symptoms with a gold standard among a large number (≥50) of consecutive patients suspected of having a UTI. Level II studies were similar to those in level I but involved a smaller number of patients (<50). Level III studies were retrospective chart reviews. Level IV studies included "grab" samples of patients (ie, nonconsecutive patients who obviously have the target condition plus, perhaps, healthy individuals without symptoms suggestive of the target condition) or made comparisons of signs or symptoms to diagnostic standards of uncertain validity among consecutive patients. Finally, level V studies included those that used a diagnostic standard of uncertain validity among "grab" samples of patients.

Data Analysis

We used published raw data from the reported studies that met our criteria to calculate summary measures for the LRs for components of the clinical examination for UTI. Likelihood ratios are related to sensitivity and specificity [positive LR=sensitivity/(1−specificity) and negative LR=(1−sensitivity)/specificity], but are more clinically useful because they can be used to generate posttest probabilities.[21] A random-effects model was used to generate conservative summary measures and confidence intervals (CIs) for the LRs and estimates of disease prevalence.[22,23] Uncertainty in these measures is reflected in the broad CIs around the estimates. When a summary LR included studies of lower quality, we conducted sensitivity analyses to examine the impact of excluding lower-quality studies on the summary LR and the effectiveness score, a measure of the discriminatory power of a diagnostic test.[24]

RESULTS

Study Characteristics

We found 9 studies of the 464 identified by the search that satisfied all inclusion criteria (TABLE 1). Six studies[25-30] reported the accuracy of 1 or more symptoms in the diagnosis of UTI, 2 studies[31,32] reported the accuracy of symptoms and physical examination signs, and 1 study reported the accuracy of self-diagnosis.[33]

The studies were published between 1965 and 2001 and generally involved patients with 1 or more symptoms of a UTI who presented to outpatient clinics. The summary prevalence of UTI in the 5 studies that included only symptomatic patients and used an appropriate gold standard was 48% (95% CI, 41%-55%),[25-28,30] indicating a high probability of disease for women who met the studies' inclusion criteria. In all of the included studies, UTI was defined by the presence of at least 10 000 or 100 000 CFU/mL of a single uropathogen, except for the most recent study, which used a cutoff of at least 100 CFU/mL.[33]

Five[25-28,30] of the 8 studies describing the accuracy of symptoms were of high quality (level I). Both studies[31,32] describing the accuracy of the physical examination were of lower quality (level III and IV) as was the study examining self-diagnosis (level V).[33] Reasons for quality scores lower than level I are shown in Table 1. Two of the lower-quality studies[29,31] received lower scores because they included patients with vaginal discharge but without symptoms of UTI and therefore did not specifically address the diagnostic accuracy of signs and symptoms exclusively in women suspected of having a UTI.

Precision

The precision of a symptom or sign refers to the degree to which different examiners report the same finding (eg, dysuria present or absent) when interviewing or examining the same patient. None of the identified studies described the precision of the history or physical examination in the diagnosis of UTI, possibly because the questions and examination procedures were considered to be unambiguous. For example, most of the historical items consist of asking yes or no questions such as "Are you having burning or pain with urination?" Variations in interview style and the phrasing of questions may affect results, but there is no information from the identified studies to suggest particular wording of questions or specific ways to examine patients for the 2 relevant physical examination signs (costovertebral angle tenderness and vaginal discharge).

Accuracy

Symptoms. Eight studies[25-32] examined the accuracy of 9 different symptoms for predicting the presence of UTI. These symptoms and the corresponding positive and negative LRs from each study are shown in TABLE 2. Three of the symptoms (flank pain, abdominal pain, fever) had both positive and negative summary LRs with CIs overlapping 1.0 and are therefore not useful as diagnostic tests.

Four symptoms significantly increased the probability of UTI: dysuria, frequency, hematuria, and back pain. Four symptoms significantly decreased the probability of UTI: absence of dysuria, absence of back pain, a history of vaginal discharge, and a history of vaginal irritation. The symptoms with the greatest diagnostic power were a history of vaginal discharge (LR, 0.3) and a history of vaginal irritation (LR, 0.2); both of these symptoms substantially reduced the probability of UTI.

Self-diagnosis. One study examined the accuracy of self-diagnosis and included 172 women in a university-based practice with recurrent UTI (more than 2 UTIs in the past year).[33] During the study period, 88 of the women reported 172 episodes of self-diagnosed UTI; 144 of these episodes (84%, 95% CI, 77%-90%) were found to have positive urine cultures. Additionally, 64 women reported mild symptoms that they did not self-diagnose as UTI and another 20 women never had symptoms. In this population of patients, the positive predictive value of self-diagnosis was very high (84%). Likelihood ratios for self-diagnosis can be calculated assuming that the women with mild symptoms or no symptoms correctly self-diagnosed with no infection (these women did not have a urine culture, but all symptoms resolved spontaneously). If this assumption is true, the LR for a positive self-diagnosis is 4.0, while the LR for a negative self-diagnosis is 0.0 (Table 2).

Combinations of Symptoms. One study[29] provided information to calculate the LRs for combinations of symptoms in the diagnosis of UTI (TABLE 3). In this study, the presence of dysuria and frequency without vaginal discharge or irritation was associated with a very high LR (24.6). Conversely, the LR for the combination of vaginal discharge or irritation without dysuria was low (0.3). While the LRs from this study must be interpreted with caution due to the study's low quality score (level IV), the observed LRs were similar to those calculated by combining the individual summary LRs from the other studies (Table 3).

Physical Examination. Two studies[31,32] reported the accuracy of 2 physical examination signs for the presence of UTI. Both studies were of relatively low quality, and therefore the summary data do not represent strong evidence of the true accuracy of these signs (Table 2). The presence of costovertebral angle tenderness increases the likelihood of infection, but the LR is only weakly predictive and similar in magnitude to the related symptom (back pain). The presence of vaginal discharge on examination decreases the likelihood of UTI (LR, 0.7) although it is less powerful than the LR for the

Table 1. Studies Used to Determine the Accuracy of Clinical History and Physical Examination in Women Suspected of Having Urinary Tract Infection (UTI)

Source, y	Methodological Quality*	Inclusion Criteria	No. of Patients	Mean Age, y	Incidence of UTI, %	Setting and Country
		Symptoms				
Gallagher et al,[25] 1965	Level I	Women with symptoms of UTI	130	. . .	59	Urban clinics in New Zealand
Mond et al,[26] 1965	Level I	Women with symptoms of UTI	83	. . .	45	General practice in the United Kingdom
Lawson et al,[27] 1973	Level I	Women aged 15-55 y with symptoms of UTI	343	. . .	47	Two general practices in the United Kingdom
Dans and Klaus,[28] 1976	Level I	Women reporting dysuria	84	26	46	US adult walk-in clinic
Komaroff et al,[29] 1978	Level IV (including women without symptoms suggestive of UTI)	Women with symptoms suggestive of urinary or vaginal infection	821	24	12	US ambulatory care facility
Nazareth and King,[30] 1993	Level I	Women aged 16-45 y presenting with frequency or dysuria	54	29	28	Two general practices in suburban London
		Self-diagnosis				
Gupta et al,[33] 2001	Level V (no urine culture in women without symptoms)	Women >18 y with a history of recurrent UTI	172	23	NA	US university-based clinic
		Symptoms and Physical Examination Findings				
Wong et al,[31] 1984	Level IV (including patients without symptoms suggestive of UTI)	Women with symptoms of UTI or with both UTI and vaginal complaints and random selection of women with vaginitis or STD	53 Cases, 139 controls	. . .	NA	US STD clinic
Wigton et al,[32] 1985	Level III (retrospective chart review)	Retrospective review of patients who had urine culture in emergency department	216 in training set, 236 in validation set	. . .	NA	US emergency department

*Methodological quality criteria are described in the "Methods" section. Reasons for methodological quality scores lower than level I are shown in parentheses. NA indicates not applicable; ellipses, not mentioned; and STD, sexually transmitted disease.

symptom of vaginal discharge reported by the patient (0.3).

Dipstick Urinalysis. Since a high-quality systematic review examining the accuracy of the dipstick urinalysis for the prediction of UTI exists, we used the data synthesized in the report by Hurlbut and Littenberg.[18] Those authors identified and summarized 51 studies and generated summary receiver operating characteristic (ROC) curves for combinations of the nitrite and leukocyte esterase dipstick tests. They found that the nitrite positive or leukocyte esterase positive combination had the greatest area under the ROC curve, indicating the most accurate test. The point on the summary ROC curve with the best accuracy represents a sensitivity of 75% and a specificity of 82%. Using these values, the positive LR for a urinalysis is 4.2 and the negative LR is 0.3 (Table 2). A range of similar points on the ROC curve that was supported by the largest number of studies was also examined, and the resulting LRs were similar in magnitude. Although other combinations of the nitrite and leukocyte esterase test will increase either sensitivity or specificity (eg, requiring both to be positive will decrease sensitivity and increase specificity), the nitrite or leukocyte esterase positive combination was the most accurate test.[18]

Sensitivity Analysis

Because the largest study to examine the accuracy of symptoms was also of lower quality,[29] we performed a sensitivity analysis to determine the effect of this study on the summary LRs. Inclusion of this study always made the symptoms (dysuria, frequency, vaginal irritation, and vaginal discharge) appear to be more powerful diagnostic tests. However, in no case did inclusion of this study improve a test with marginal discriminatory power into the highly effective range (effectiveness score $\geq$3.0).[24] The positive and negative LRs for dysuria and frequency excluded 1.0, whether or not the study was included, with 1 exception. The positive LR for increased urinary frequency was

Table 2. Clinical Signs and Symptoms in the Prediction of Urinary Tract Infection*

Study	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)
	Dysuria	
Gallagher et al[25]	1.3 (1.1-1.6)	0.3 (0.1-0.7)
Mond et al[26]	1.4 (1.1-1.8)	0.2 (0.1-0.7)
Lawson et al[27]	1.2 (1.0-1.5)	0.8 (0.6-1.0)
Nazareth and King[30]	1.1 (0.8-1.1)	0.6 (0.1-2.4)
Komaroff et al[29]	3.2 (2.7-3.7)	0.2 (0.1-0.3)
Wong et al[31]	3.0 (2.0-4.6)	0.5 (0.4-0.7)
Wigton et al[32] (training set)	1.4 (1.1-1.8)	0.7 (0.5-0.9)
Wigton et al[32] (validation set)	1.1 (0.8-1.4)	0.9 (0.7-1.2)
Summary	**1.5 (1.2-2.0)**	**0.5 (0.3-0.7)**
	Frequency	
Gallagher et al[25]	1.0 (0.9-1.1)	1.6 (0.4-5.9)
Mond et al[26]	1.0 (0.9-1.1)	1.1 (0.2-7.8)
Lawson et al[27]	1.1 (1.0-1.3)	0.7 (0.4-1.0)
Dans and Klaus[28]	1.4 (1.0-2.1)	0.6 (0.4-1.1)
Nazareth and King[30]	1.0 (0.8-1.3)	0.9 (0.2-3.8)
Komaroff et al[29]	10.3 (7.8-13.3)	0.1 (0.0-0.2)
Wong et al[31]	5.2 (3.1-8.7)	0.5 (0.3-0.6)
Wigton et al[32] (training set)	1.8 (1.0-3.5)	0.9 (0.8-1.0)
Wigton et al[32] (validation set)	1.3 (0.8-2.0)	0.9 (0.8-1.1)
Summary	**1.8 (1.1-3.0)**	0.6 (0.4-1.0)
	Hematuria	
Gallagher et al[25]	1.8 (0.8-3.9)	0.9 (0.8-1.0)
Mond et al[26]	2.9 (1.0-8.6)	0.8 (0.7-1.0)
Nazareth and King[30]	6.5 (1.4-30)	0.7 (0.5-1.0)
Wigton et al[32] (training set)	1.6 (0.8-3.3)	0.9 (0.8-1.0)
Wigton et al[32] (validation set)	1.4 (0.6-3.4)	0.9 (0.9-1.1)
Summary	**2.0 (1.3-2.9)**	0.9 (0.9-1.0)
	Fever	
Gallagher et al[25]	2.4 (1.2-4.9)	0.8 (0.6-0.9)
Mond et al[26]	2.7 (0.8-9.9)	0.9 (0.7-1.0)
Lawson et al[27]	0.6 (0.3-1.3)	1.0 (1.0-1.1)
Nazareth and King[30]	0 (0-175)	0.9 (0.8-1.1)
Wigton et al[32] (training set)	1.5 (0.7-3.0)	0.9 (0.8-1.0)
Wigton et al[32] (validation set)	2.1 (1.0-4.6)	0.9 (0.8-1.0)
Summary	1.6 (1.0-2.6)	0.9 (0.9-1.0)
	Flank Pain	
Gallagher et al[25]	1.1 (0.6-1.7)	1.0 (0.8-1.3)
Mond et al[26]	1.1 (0.5-2.2)	1.0 (0.6-1.3)
Lawson et al[27]	1.1 (0.9-1.4)	0.9 (0.8-1.1)
Summary	1.1 (0.9-1.4)	0.9 (0.8-1.1)
	Lower Abdominal Pain	
Gallagher et al[25]	1.0 (0.8-1.3)	1.0 (0.6-1.6)
Mond et al[26]	1.2 (0.7-2.1)	0.9 (0.6-1.3)
Wong et al[31]	1.5 (0.9-2.4)	0.9 (0.7-1.1)
Summary	1.1 (0.9-1.4)	0.9 (0.8-1.1)
	Vaginal Discharge	
Dans and Klaus[28]	0.8 (0.5-1.2)	1.3 (0.8-2.0)
Komaroff et al[29]	0.1 (0.1-0.2)	12.0 (8.9-16.1)
Wong et al[31]	0.4 (0.3-0.7)	1.9 (1.4-2.5)
Summary	**0.3 (0.1-0.9)**	3.1 (1.0-9.3)

(continued)

1.8 (95% CI, 1.1-3.0) when all studies were included vs 1.4 (95% CI, 1.0-1.9) when the study was excluded. That study[29] has a larger impact on the diagnostic value of vaginal symptoms because fewer studies were involved. The absence of vaginal discharge, a feature reported in only 3 studies, makes a UTI more likely whether or not this study[29] is included (LR, 3.1 [95% CI, 1.0-9.3] for all studies vs LR, 1.7 [95% CI, 1.3-2.2] when excluded). The presence of vaginal discharge still lowers the likelihood of a UTI whether or not the study by Komaroff et al[29] is included (LR, 0.3 [95% CI, 0.1-0.9] for all studies vs LR, 0.6 [95% CI, 0.4-0.9] when the study is excluded). The impact on the efficiency of using the symptom of vaginal irritation is seen from Table 2 as only 2 studies evaluated this feature.

Table 2. Clinical Signs and Symptoms in the Prediction of Urinary Tract Infection* (cont)

Study	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)
Vaginal Irritation		
Komaroff et al[29]	0.1 (0.0-0.2)	6.2 (5.0-7.6)
Wong et al[31]	0.6 (0.4-1.1)	1.2 (1.0-1.5)
Summary	**0.2 (0.1-0.9)**	2.7 (0.9-8.5)
Back Pain		
Wigton et al[32] (training set)	1.7 (1.1-2.6)	0.8 (0.7-1.0)
Wigton et al[32] (validation set)	1.6 (1.1-2.5)	0.8 (0.7-1.0)
Nazareth and King[30]	0.8 (0.3-2.5)	1.1 (0.8-1.5)
Summary	**1.6 (1.2-2.1)**	**0.8 (0.7-0.9)**
Self-diagnosis		
Gupta et al[33]	**4.0 (2.9-5.5)**	**0.0 (0.0-0.1)**
Vaginal Discharge on Physical Examination		
Wong et al[31]	0.8 (0.7-1.0)	1.9 (1.1-3.3)
Wigton et al[32] (training set)	0.3 (0.1-0.9)	1.1 (1.0-1.2)
Wigton et al[32] (validation set)	0.4 (0.2-1.0)	1.1 (1.0-1.2)
Summary	**0.7 (0.5-0.9)**	1.1 (1.0-1.2)
Costovertebral Angle Tenderness on Physical Examination		
Wigton et al[32] (training set)	2.0 (1.2-3.4)	0.8 (0.7-0.9)
Wigton et al[32] (validation set)	1.4 (0.8-2.4)	0.9 (0.8-1.0)
Summary	**1.7 (1.1-2.5)**	0.9 (0.8-1.0)
Dipstick Urinalysis†		
Hurlbut and Littenberg[18]	4.2	0.3

*CI indicates confidence interval. The study by Wigton et al[32] included 2 separate sets of patients evaluated by retrospective chart review: a training set and a validation set. Likelihood ratios in bold are significant.
†A positive result was defined as leukocyte esterase positive or nitrite positive; a negative result was defined as both negative.

Table 3. Likelihood Ratios (LRs) for Combinations of Symptoms

Symptom Combinations	Summary LR Using Combinations of Individual Symptoms*	Based on Data From Komaroff et al[29]	
		Posttest Probability of UTI, %†	Summary LR‡
Dysuria present	1.5	77	
Frequency present	1.8		
Vaginal discharge absent	3.1		
Vaginal irritation absent	2.7		
Overall	22.6		24.6
Dysuria absent	0.5	4	
Vaginal discharge or irritation present	0.3 or 0.2		
Overall	0.1-0.2		0.3
Dysuria or frequency present	1.5 or 1.8	9	
Vaginal discharge or irritation present	0.3 or 0.2		
Overall	0.3-0.5		0.7

*The LR theoretical was calculated by multiplying the summary LRs from Table 2 for each of the findings in each set of symptom combinations.
†The pretest probability of urinary tract infection (UTI) in the study by Komaroff et al was 12% (the prevalence of UTI in the study).[29]
‡Likelihood ratios were calculated from the observed change in the pretest and posttest probability of UTI; confidence intervals cannot be calculated because the raw data were not available.

COMMENT

Symptoms suggestive of UTI are common complaints of young women seeking urgent medical care. Although textbooks of clinical medicine[15-17] routinely mention many of the symptoms and signs of UTI, the overall accuracy of these symptoms and signs has not previously been critically and systematically evaluated. A clear understanding of the value of each of these diagnostic tests may enable physicians to make more informed decisions about the choice of specific tests and management options.

Rule Out Complicated UTI

The initial step is to be certain that the patient does not have a complicated UTI as defined by the factors listed earlier (see "Definitions"). The probability of UTI in patients with risk factors for a complicated infection is not known because these patients were not included in the studies identified by our search. Such patients may be at greater risk of treatment failure,[10] and clinicians may want to consider early urine culture and empirical treatment as shown at the top of the proposed algorithm (FIGURE).

Pretest Probability and the Diagnostic Value of Presenting to a Clinician

Using a standard evidence-based technique,[21] a clinical encounter begins with an estimation of the pretest probability of disease followed by the application of

1 or more diagnostic tests to determine the posttest probability of disease. We consider the pretest probability of UTI to be equal to the prevalence observed in studies of asymptomatic bacteriuria, or approximately 5%.[11,12] In this review, 5 studies reported the prevalence of UTI in patients presenting with 1 or more symptoms of acute UTI, and the summary prevalence was 48% (95% CI, 41%-55%).

Interestingly, the probability of UTI changes substantially when a patient presents to a clinician, increasing from 5% (in historical controls without symptoms) to approximately 50% (in patients in the included studies who presented with 1 or more symptoms). This change in probability corresponds to an LR of 19, representing a very powerful "diagnostic test." Clinically, it is useful to know that patients who present with 1 or more symptoms of UTI have a very high probability of infection. Since all of the studies included in this review evaluated the diagnostic value of symptoms and signs after patients presented to a clinician, the relevant pretest probability for these tests is 50%.

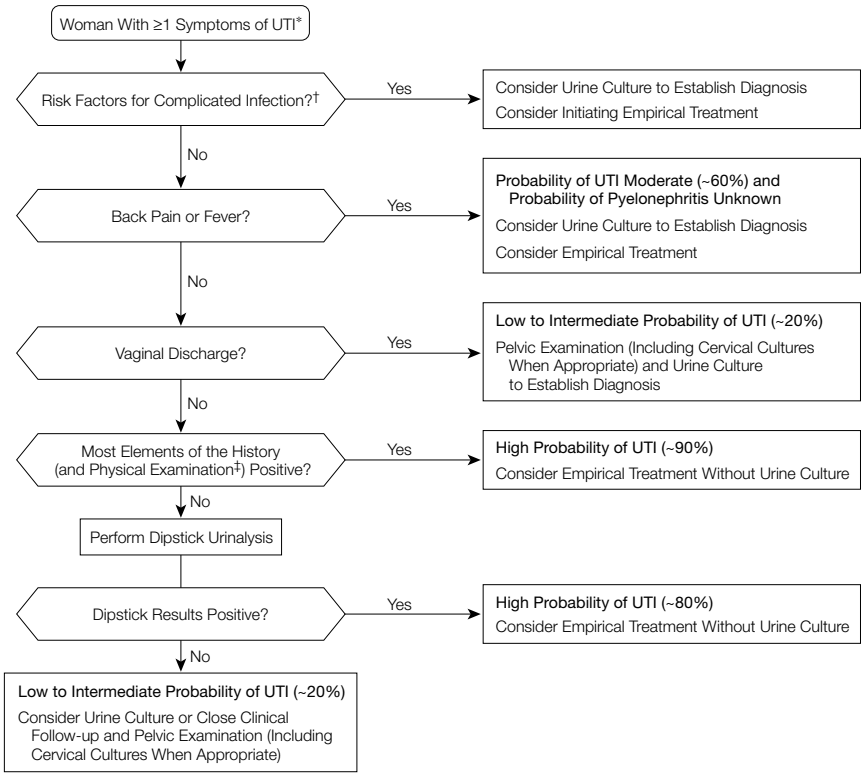
Although the pretest probability of UTI in the average patient who presents with 1 or more symptoms is approximately 50%, this varies considerably according to the individual's risk profile. There are 3 well-established risk factors for acute UTI in young women: recent sexual intercourse,[3,34-38] use of spermicide (on condoms or with diaphragms) during sexual intercourse,[3,34-36,39,40] and history of UTI.[3,36] Other risk factors, including a maternal history of UTI,[34] a history of childhood onset of UTI,[34] and the presence of bacterial vaginosis,[41] also have been found to be associated with UTI. The presence of any of these risk factors increases the pretest probability of UTI and should be considered when evaluating patients. Unfortunately, the diagnostic power of these risk factors (sensitivity, specificity, or LRs) is not known, as the majority of studies assessing these risk factors used a case-control design or did not present sufficient data to calculate LRs.[3,4,35-39,42] Further research is needed to determine the diagnostic power of these risk factors so that the information can be used during the clinical encounter to estimate the pretest probability of disease.

Refining Probability Using the History and Physical Examination

In the included studies, all diagnostic tests were evaluated by their ability to change the already very high (50%) probability of UTI in the study population. Because these patients initially presented with at least 1 symptom, some of the power of each symptom was already "used up" by the time the patient presented to a clinician (and the probability of UTI increased from 5% to 50%). In a sense, the diagnostic power of the symptom is being "used" twice. Initially, the presenting symptom (most commonly dysuria or frequency) caused the patient to present to a clinician and was at least partially responsible for raising the probability of UTI from 5% to 50%. Subsequently, the value of the presenting symptom and all other potentially relevant symptoms was assessed after presentation to a clinician.

It is therefore not surprising that most of the individual symptoms and signs have LRs relatively close to 1.0 and therefore do not have great additional diagnostic power after presentation. The main exception to this finding is the history of vaginal discharge or vaginal irritation, which substantially reduces the probability of UTI.

Figure. Proposed Algorithm for Evaluating a Women With Symptoms of Acute Urinary Tract Infection (UTI)



*In women who have risk factors for sexually transmitted diseases, consider testing for chlamydia. The US Preventive Services Task Force recommends screening for chlamydia for all women 25 years or younger and women of any age with more than 1 sexual partner, a history of sexually transmitted disease, or inconsistent use of condoms.[52]

†For a definition of complicated UTI see the "Definitions" section of the text.

‡The only physical examination finding that increases the likelihood of UTI is costovertebral angle tenderness, and clinicians may consider not performing this test in patients with typical symptoms of acute uncomplicated UTI (as in telephone management).

One study found that back pain and costovertebral angle tenderness were useful for predicting the presence of UTI.[32] This study was a retrospective chart review of patients who had a urine culture in an emergency department, and it is possible that back pain and costovertebral angle tenderness were predictive of upper UTI (pyelonephritis). However, since none of the included studies performed a gold standard test for upper UTI, we were unable to determine if individual symptoms and signs were more predictive of upper vs lower UTI. Most patients with symptoms suggestive of UTI and features classically associated with upper UTI (back pain, fever) are evaluated and treated for presumed pyelonephritis (Figure), even though the diagnostic accuracy of these signs and symptoms for predicting upper UTI is not known. Since most patients in the included studies did not have back pain and fever, we believe that the other symptoms evaluated in our review are most useful for predicting lower UTI (cystitis).

In contrast to the value of individual tests, certain combinations of symptoms result in large changes in the probability of UTI and represent powerful diagnostic tests. The combination of dysuria and frequency without vaginal discharge or irritation corresponds to an LR of 24.6. Although the combined LRs were generated from only one study of lower quality,[29] these LRs were similar to those found when multiplying the summary LRs for the individual symptoms, suggesting that they are reasonable estimates of the true diagnostic power of these combinations. In addition, another study[43] that was excluded from our analysis (because it included an unknown number of asymptomatic patients) used the same combinations of symptoms and found similar positive predictive values and LRs.

Although evaluated in only one study,[33] self-diagnosis appears to be a useful diagnostic test (LR, 4.0) in women with recurrent UTI. Because this study did not perform urine cultures for women with mild or no symptoms, there is some uncertainty in the LR estimates. Similarly, the study population consisted of mostly highly educated single white women, and it is not clear if the results apply to other groups of women. Nonetheless, these findings suggest that women learn to recognize the symptoms of UTI and are able to accurately diagnose a new infection, a finding that deserves further study and may have important implications for management of this large group of patients.

Refining Probability Using Dipstick Urinalysis

Dipstick urinalysis alone is a moderately powerful diagnostic test (Table 2). If the dipstick is used alone, the posttest probabilities for women with symptoms of a UTI are 81% (positive result) and 23% (negative result).

A Diagnostic Algorithm for Evaluating Patients With Symptoms of UTI

The Figure shows a proposed algorithm for evaluating patients with symptoms of UTI. Although the algorithm itself has not been prospectively studied, the recommendations are based on the posttest probabilities of UTI generated from the summary LRs in the current analysis (Table 2). In women with risk factors for a complicated UTI or with back pain, fever, or malaise (suggesting possible pyelonephritis), a urine culture with initial empirical treatment is recommended. If a woman reports a history of vaginal discharge, the posttest probability of UTI from this single historical item is reduced to 23%, and a pelvic examination to rule out a vaginal infection should be considered in addition to a dipstick urinalysis and urine culture.

The algorithm highlights the finding that the history and physical examination alone can substantially increase the posttest probability of UTI, effectively "ruling in" the diagnosis. Since the only physical examination finding that increases the probability of UTI is costovertebral angle tenderness, the physical examination may be omitted without a substantial loss of diagnostic power in patients without a history of vaginal discharge or irritation. Using individual summary LRs, a patient with dysuria, frequency, and hematuria (but no back pain at this point in the algorithm) has a posttest probability of UTI of 81%; using the combined LR estimate of dysuria and frequency without vaginal discharge (LR, 24.6), the posttest probability of UTI is 96%. Given these very high probabilities of UTI, clinicians should consider empirical treatment without urine culture or dipstick urinalysis.

Conversely, even mostly negative history, physical examination findings, and dipstick urinalysis cannot reliably rule out the diagnosis of UTI in women without a history of vaginal discharge or irritation. For example, to generate the lowest possible posttest probability of disease, a woman must still present with at least 1 symptom. If she presents with frequency (LR, 1.8) with no dysuria (LR, 0.5) and no back pain (LR, 0.8) (the only 2 negative symptoms other than vaginal symptoms), a negative dipstick result (LR, 0.3), and no other positive symptoms, her posttest probability of disease is still 18%, which is considerably higher than the prevalence of asymptomatic bacteriuria in the population (5%). Although we do not address the optimum management of such patients, we believe that the relatively high probability of UTI (~20%) warrants a urine culture (Figure), an approach that has been supported by others.[10] Clinicians may also want to consider performing a pelvic examination, especially in patients at high risk for sexually transmitted disease or if the urine culture is negative and symptoms persist. As noted, it is theoretically possible to rule out UTI in women who present with vaginal discharge, where the lowest possible posttest probability of disease is 6% (if they also have no dysuria, no back pain, a negative dipstick result, and no other positive symptoms). We recommend that clinicians consider obtaining a urine culture in patients with at least 1 urinary symptom and vaginal discharge, since

the posttest probability of disease will only rarely reach this lowest possible 6%.

If the history and physical examination are neither strongly positive nor negative, a positive dipstick result still results in a high posttest probability of disease (approximately 80%), and empirical therapy should again be considered without urine culture. In all of the scenarios in the algorithm urine culture may be indicated, without regard to the posttest probabilities, if the patient has experienced recurrent infection and antibiotic resistance is suspected.

Older guidelines for the evaluation of patients with suspected UTI recommend urine culture in all patients, even in those found to have a high probability of UTI after the history and physical examination.[29,44] More recent reviews and management strategies suggest that a diagnosis of UTI can be established in women who present with typical symptoms and are found to have a positive dipstick or urinalysis result (without obtaining a urine culture).[10,45-48]

Unlike these treatment recommendations, our proposed algorithm (Figure) suggests that, in selected patients with mostly positive symptoms, the probability of UTI is so high (~90%) that empirical treatment may be considered without dipstick testing or urinalysis. A similar strategy was recently evaluated in a randomized trial comparing management via telephone with office evaluation in 72 women with suspected UTI.[49] The investigators found no difference in symptom scores or patient satisfaction with the 2 strategies. Prior studies examining the effect of symptom-based management of patients with suspected UTI (after a telephone call or office visit to a health care provider) have shown that empirical therapy decreases costs without increasing adverse outcomes.[50,51] However, the main purposes of the current algorithm are to define the posttest probabilities of disease from specific clinical scenarios and to allow clinicians to make informed testing and treatment decisions based on their clinical judgment. Further research is needed to determine clinical outcomes, costs, and patient satisfaction associated with different testing and treatment strategies for managing patients who present with specific constellations of symptoms of UTI.

SCENARIO RESOLUTION

In the first case, the woman has 2 symptoms of UTI (dysuria and frequency), no vaginal discharge, and believes that her current symptoms are similar to prior episodes. These features all increase her probability of UTI, which is greater than 90%. Her sexual history does not suggest that she is at high risk for a sexually transmitted disease. Using the algorithmic approach, the patient should be asked about risk factors for complicated infection as well as symptoms classically associated with pyelonephritis (fever, back pain, nausea, vomiting). As has been shown, telephone evaluation and treatment of similar patients may be an appropriate strategy.[49,50] In this patient, a positive dipstick urinalysis result would further increase the probability of UTI, while a negative result would not rule out infection.

In the second case, the woman has 2 symptoms of UTI (dysuria and frequency) as well as vaginal discharge (which decreases the probability of UTI and increases the probability of vaginal infection). A pelvic examination does not suggest a specific diagnosis and the dipstick urinalysis result is negative. The posttest probability of UTI is approximately 20%, illustrating that even a negative physical examination and dipstick test result are insufficient to rule out UTI in a patient with 1 or more symptoms. A urine culture will help determine the need for treatment, and cervical cultures are indicated to rule out chlamydia and gonorrhea and help determine the cause of her symptoms.

BOTTOM LINE

In a woman who presents with 1 or more symptoms of UTI, the probability of infection is high (approximately 50%). Four symptoms (dysuria, frequency, hematuria, and back pain) and 1 sign (costovertebral angle tenderness) increase the probability of UTI when present. Combinations of symptoms can substantially increase the likelihood of UTI, effectively ruling in the disease based on the history alone. Patients with recurrent infection may be able to accurately self-diagnose UTI.

In contrast, the history and physical examination cannot reliably rule out UTI in women who present with urinary symptoms. Although 4 symptoms (absence of dysuria, absence of back pain, and a history of vaginal discharge or vaginal irritation) and 1 sign (vaginal discharge) decrease the probability of UTI, even combinations of symptoms, signs, and a negative dipstick result rarely lower the probability of UTI below 20%. A urine culture and pelvic examination should be considered in patients who present with some symptoms of UTI but with mostly negative history and physical examination findings.

Dipstick urinalysis, which is a simple and inexpensive test, is moderately powerful and should be considered in women with appropriate urinary tract symptoms. If the dipstick result is positive, the probability of UTI is high, especially when combined with other positive findings from the history and physical examination. If the dipstick result is negative, the probability of disease is still relatively high (23%) and a urine culture should be considered to rule out infection.

Care should be taken to identify women with vaginal discharge or vaginal symptoms. If present, a pelvic examination and cervical culture are indicated to rule out infection due to chlamydia[52] or gonorrhea, as well as other vaginal infections that require definitive therapy. Similarly, in women with back pain, fever, or significant malaise, an office examination, combined with dipstick urinalysis and urine culture, may aid in the diagnosis of pyelonephritis, although the accuracy of individual tests for establishing upper UTI is not known.

Knowledge of the LRs for specific symptoms, signs, and diagnostic tests

used to evaluate patients with suspected UTI may improve the ability of clinicians to more accurately predict the probability of infection in individual patients. It seems reasonable to offer empirical treatment when the probability of infection is high and to pursue additional diagnostic testing (eg, urine culture, pelvic examination, and cervical cultures) when the probability of UTI is low or intermediate. However, the actual cost-effectiveness of specific testing and treatment strategies is not clearly established, and prospective studies examining clinical benefits, adverse effects, costs, and patient satisfaction with specific approaches are needed.

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