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ADULT PATIENTS' LABORATORY DIAGNOSIS OF URINARY TRACT INFECTIONS

Abdualwahab Mohamed Madkali , Abdulaziz Dakhil Saad Alshahrani , Khalid Moadi Assiri , Ali Abdullah Mohmmed Alkhathami , Hajar Ali Alhasani , Fareah Ali Abutalib Alhassani , Mariam Mustafa Bbutalib Alhasani , Hamad Ali Ali Alhayli , Mohammed Ahmed Ibrahim Alsahabi , Abdulaziz Fayez Almoslei , Asrar Hasan Algubishi

Abstract:

One of the most frequent bacterial infections, urinary tract infections (UTIs) make up a large portion of the workload in clinical microbiology labs. The most common cause of urinary tract infections (UTIs) is still enteric bacteria, especially Escherichia coli, albeit the location of these pathogens is shifting. The rise of resistance to certain antimicrobial agents—most notably, E's resistance to trimethoprim-sulfamethoxazole—is more significant. Coli. A limited number of assays are used by doctors to differentiate UTIs from other infections with comparable clinical presentations; however, none of these tests have sufficient sensitivity or specificity when used alone. Urinalysis is a valuable diagnostic test mostly for ruling out bacteriuria. Urine culture may not be required for the examination of outpatients with simple UTIs, but it is required for inpatients with UTIs as well as for outpatients with severe UTIs, recurring UTIs, and treatment failures.

keywords: Urinary tract infections (UTIs), Laboratory diagnosis, Adult patients, Antimicrobial resistance

Introduction:

Among the most prevalent bacterial infections are urinary tract infections (UTIs). Up to 7 million visits to outpatient clinics, 1 million trips to emergency rooms, and 100,000 hospitalizations are thought to occur from symptomatic UTIs each year [1]. As the second most common cause of bacteremia in hospitalized patients, UTIs have emerged as the most prevalent hospital-acquired infection, accounting for up to 35% of nosocomial infections [2, 3]. An approximate of $1.6 billion is projected to be the annual cost to the US health care system from community-acquired UTIs alone [4].

The high number of infections that happen every year and the difficulty in diagnosing UTIs make them difficult medical conditions. Some UTIs are asymptomatic or present with atypical signs and symptoms, and the diagnosis of UTIs in neutropenic patients—who do not typically have pyuria—may require different diagnostic criteria than those used for the general patient population. Physicians must also distinguish UTIs from other diseases that have similar clinical presentations. These factors make it common for doctors to rely on a limited number of subpar laboratory tests to support clinical impressions; even in cases where a clinical diagnosis is clear-cut, doctors may still order laboratory tests to determine the infection's cause and/or to obtain isolates for testing against antibiotics. Therefore, it should come as no surprise that a significant portion of the workload in many hospital-based laboratories is devoted to the laboratory investigation of urine specimens. Urine cultures really make up the majority of submitted cultures in many clinical laboratories, making up between 24 and 40 percent of all cultures; up to 80 percent of these urine cultures come from outpatient settings. This review's objective is to provide an overview of the laboratory diagnosis of a typical UTI utilizing the most recent diagnostic techniques. The diagnosis of UTI in specific patient demographics is not included in this review because it is a topic best left for a different one.

REASONS FOR UTIs

UTIs acquired in hospitals and the community have different etiological agents (table 1) [5–14]. There is a dearth of published data on variations in the frequency of causative agents among outpatients. Enteric bacteria, specifically Escherichia coli, have been and continue to be the most common type of bacterium. cause of UTI, despite some evidence suggesting that E is the source of a percentage of UTIs. Coli is not as common [6, 15]. However, since 1980, there have been documented alterations in the causes of nosocomial UTI. According to Bronsema et al. [13], between 1980 and 1991, the proportion of UTIs brought on by E. UTIs caused by yeasts, group B streptococci, and Klebsiella pneumoniae grew in percentage, whereas those caused by E. Coli, Proteus species, and Pseudomonas species dropped. The percentage of UTIs caused by Enterobacter species decreased, but the percentage of UTIs caused by Acinetobacter species and Pseudomonas aeruginosa increased, according to Weber et al.'s [6] research on variations in UTI causative agents. The most frequent cause of funguria is Candida albicans, which is followed by other yeasts, Candida glabrata, Candida tropicalis, Candida parapsilosis, Candida krusei, and others [16].

Transporting, gathering, and processing specimens
Collection of specimens. The easiest way to prevent specimens from being contaminated with bacteria in the distal urethra is to sterilize them. This method of collection is rarely widely utilized since it is intrusive and painful, takes too much time and money to be practical, and is not suggested clinically (except in very rare circumstances). The next best method for obtaining urine specimens with minimal contamination is to use a single catheter (straight catheter technique). However, this method is invasive, too labor-intensive, and expensive for routine use,

so it is not recommended clinically for the majority of patients. It has additional drawbacks because uncommon problems have been recorded and the procedure of placing a catheter through the urethra may introduce germs into the bladder, leading to a UTI.

Adult patients typically have their urine specimens collected using the clean-catch midstream approach. The benefits of this treatment are as follows: it can be performed in nearly any therapeutic setting, it is straightforward, inexpensive, and neither invasive nor uncomfortable; also, there is no risk of problems or the introduction of microorganisms into the bladder through catheterization. Urine specimens obtained using this technique have quite good correlations with those obtained through straight catheterization or suprapubic aspiration when it comes to colony counts [15]. The obvious drawback of this method is that the urine sample can get contaminated with commensal bacteria as it travels down the distal urethra. The first portion of the urine stream should be allowed to pass into the toilet, cleaning the skin and mucous membranes next to the urethral orifice before micturition, and collecting urine for culture from the midstream are simple measures that have been developed to reduce the contamination rate [17].

Despite the widespread acceptance and usage of the clean-catch midstream approach, the existing evidence implies that the cleaning techniques might not have a substantial impact on urine contamination rates and, as a result, might not be required on a regular basis [18–23]. It is very important to collect specimens appropriately to prevent contamination since older patients and patients with physical or other forms of impediments may have issues with effective sample collection.

The technique utilized to collect the specimen affects the proper handling and processing of urine samples as well as the interpretation of test results, as will be covered in more detail below. Thus, it should go without saying that doctors should indicate the method of collection on the test requisition sheet. The date and time of specimen collection, patient demographics, and any clinically relevant information (such as the patient's use of antibiotics or the presence of anatomic abnormalities, stones, or an indwelling urinary catheter) should also be included on the test requisition slip.

Transport of specimens.Numerous investigations have demonstrated the detrimental impact on urine specimen quality that occurs when transportation or processing delays occur [24–26]. Urine specimens were collected for each research, plated within two hours, and then plated again up to twenty-four hours later. The purpose of the comparison of the data was to ascertain whether plating delays led to an increase in colony counts. False-positive results were produced in each study because some of the delayed cultures had increases in colony forming units (cfu) per milliliter, reaching 1105 cfu/mL. It is important to remember that these three studies were conducted prior to the current set of guidelines for interpreting quantitative urine cultures [15]. Additionally, the impact on interpretation would have been even higher had colony counts of 102

or 103 cfu/mL been used to determine the likelihood of infection in particular patients. Urine specimens should be plated within two hours of collection, unless they have been refrigerated or preserved, according to the findings of these and other investigations of a similar kind [17].

Processing of specimens.For the semiquantitative approach, calibrated loops should be used to plate routine urine cultures. This approach has the benefit of offering data on the concentration of cfu/mL in addition to isolated colonies for susceptibility testing and identification. Only Blood Agar and MacConkey's Agar should be utilized as medium types for routine cultures. Since almost all UTIs in outpatients are caused by facultative and aerobic gram-negative bacteria (table 1), it is not required to regularly inoculate urine specimens obtained from patients with a medium that is selective for gram-positive bacteria [27, 28]. Selective media does not need to be used, even in patient populations where Staphylococcus saprophyticus is a common cause of UTIs. However, hospitalized patients' urine samples are more likely to include enterococci, which have been identified as the second most Techniques for the Culture of UTIs for Laboratory Diagnosis bacteriuria detection using urine microscopy. Using Gram staining of un-centrifuged urine specimens, Gram staining of centrifuged specimens, or direct examination of bacteria in urine specimens, bacteriuria can be identified microscopically.

An easy procedure to use is the Gram stain on uncentrifuged urine specimens. A glass microscope slide is filled with a volume of pee, let to air dry, stained with Gram stain, and then inspected under a microscope. Due to the fact that several standards have been applied to establish a positive test result, the performance characteristics of the test are not clearly defined. According to one study (table 2) [28], the test is sensitive for detecting 105 cfu/mL but insensitive for detecting smaller amounts of bacteria. The test's limited sensitivity for detecting UTIs has been reported by several researchers [33–42].

The urine Gram stain test has the significant benefit of instantly revealing the type of infecting bacterium or yeast (rarely infectious organisms like microsporidia), which helps the doctor choose the most appropriate empirical antibiotic therapy. Although this is significant in certain contexts, the Gram stain test's utility in the majority of clinical situations is constrained by three drawbacks. First of all, the test is insensitive; illnesses with bacterial concentrations of 102–103 cfu/mL may not be detected by it. It is only consistently positive when the amount of germs in the urine is "105 cfu/mL." Secondly, the test requires too much work to be feasible for most clinical microbiology laboratories to perform more than a few times a year. Lastly, it shouldn't be utilized in the outpatient context for patients with simple UTIs since it might not be able to identify bacteria at concentrations of 102–103 cfu/mL. Its usage should be restricted to patients with acute pyelonephritis, individuals with invasive UTIs, or those patients for whom it is critical to know the kind of infecting bacteria right once due to these restrictions. bacteriuria detection with the nitrite test. When bacteria convert nitrate to nitrite, bacteriuria can be identified chemically.

The Enterobacteriaceae family of pathogens, which cause UTIs most frequently, are linked to the biochemical reaction that the nitrite test detects. However, the test's utility is restricted because S and other urinary tract pathogens are not linked to the production of nitrite. enterococci, Pseudomonas species, or saprophyticus [43]. Since "4 h are required for bacteria to convert nitrate to nitrite at levels that are reliably detectable," another disadvantage of the test is that it necessitates testing a specimen of the first urine generated in the morning. urine microscopy for pyuria detection. By monitoring the urinary leukocyte excretion rate, counting leukocytes with a hemacytometer, counting leukocytes in urine specimens using Gram staining, or counting leukocytes in a centrifuged specimen, pyruria can be identified and measured microscopically. The ability to view leukocytes, leukocyte casts, and other biological components directly is one of urine microscopy's benefits. Leukocytes degrade quickly in urine that is not fresh or that has not been sufficiently stored, which is a drawback of urine microscopy. Furthermore, each of these approaches has drawbacks that reduce their use as standard tests [28]. Urine microscopy should only be performed on patients who are suspected of having pyelonephritis or other more serious diseases due to these drawbacks.

The urine leukocyte excretion rate is the most precise microscopic technique for quantifying pyuria [43]. Urinary leukocyte excretion rates in patients with symptomatic UTIs are "400,000 leukocytes/h" [43]. However, the test is not practicable for clinical usage, necessitating the employment of alternative techniques in laboratories. Using a hemocytometer to count urine leukocytes is an easy and affordable substitute. Hemocytomer counts of "10 leukocytes/mm3" have been found to correlate well with urine leukocyte excretion rates. Pyuria detection using leukocyte esterase assays. Leukocyte Proteins having esterolytic activity hydrolyze ester substrates, which is the basis for esterase assays [44]. Neutrophils in humans can produce up to ten proteins that have esterolytic activity. The amount of esterase in the material is shown by the color change that results from these proteins' reaction with ester substrates to form alcohols and acids, which then react with other substances [44]. Because of the benefit of these tests being able to identify esterases in both intact leukocytes and those released during cell lysis, even non-preserved material correctly could result in a positive test outcome. When bacteria found in vaginal fluid are present in the urine, when eosinophils or Trichomonas species are present in the specimen, which can both act as sources of esterases, or when oxidizing agents or formalin react with the test strips to produce false-positive test results, leukocyte esterase tests may produce false-positive results [44, 45].

Reduced positive test results for leukocyte esterase tests can occur when the specimen has high specific gravity, high protein, and/or high glucose levels; when boric acid preservatives are present; when ascorbic or oxalic acid concentrations are high; and when the patient has taken antimicrobial medications like cephalothin, cephalexin, or tetracycline [44, 45]. Test results that are falsely negative can be caused by high tetracycline concentrations [45]. Table 3 illustrates

that the leukocyte esterase test, when utilized in isolation, has a lower positive predictive value, lower sensitivity, and lower specificity when used to diagnose UTIs [28, 35, 38, 46–54].

simultaneous finding of pyuria and bacteriuria. Com- Commercial urinalysis kits provide tests for leukocyte esterase and nitrite, covering pyuria and bacteriuria. The performance features of these tests have been specified by several clinical evaluations, as table 3 illustrates. The investigations were conducted over a 20-year span in a variety of laboratories and healthcare settings, with a diversity of study designs, and the use of diverse commercial items, thus the evaluations are not directly comparable.

the research. However, there is enough consistency in the results to draw certain inferences. First, the combined scores of the two tests outperform the scores of each test taken separately. According to reference [51], tests exhibit superior performance characteristics when identifying bacteriuria at high colony counts as opposed to low colony counts. Thirdly, there are poor positive predictive values, large negative predictive values, low sensitivity, and high specificity associated with these tests. When combined, these tests' performance characteristics make them a valuable tool for ruling out bacteriuria based on negative test results.

Urine tests that are reliant on the interpretation of color variations may be affected by medicines that cause anomalous urine color. This may lead to false-positive interpretations in certain situations and mask color shifts in others [45].

CULTURES AND LABORATORY UTI DIAGNOSIS

routine cultures of microorganisms in urine. When evaluating outpatients with simple UTIs, urine cultures may not be required [55, 56]. Urine cultures, however, are required for outpatients with severe UTIs, recurring UTIs, or treatment failures. Additionally, urine cultures are required for hospitalized individuals who get UTIs. Not only does the bacterial culture aid in the documentation of infection, but it is still a crucial test in the diagnosis of UTI.

essential for assessing antimicrobial sensitivity and identifying the contaminating bacterium or microorganisms. The rising prevalence of antibiotic resistance makes this especially true. "105 cfu per milliliter of urine" is the most widely used criterion for defining substantial bacteriuria [15, 57, 58]. Though the criterion is frequently used to various patient populations, it was originally developed specifically for women with acute pyelonephritis or women who were asymptomatic but had multiple urine cultures that yielded this number of bacteria [15]. However, the majority of UTI patients do not fit into either group, and between 30% and 50% of patients who have acute urethral syndrome will have colony counts of!105 CFU/mL [15]. Because of this, a lot of labs have chosen to interpret and report results using reduced colony counts as a criterion. A colony count of 104 cfu/mL is one typical requirement, which should raise the test's sensitivity without making it too difficult for laboratories and physicians to utilize.

If the specimens are obtained by suprapubic aspiration or catheterization, the colony counts of many patients with lower urinary tract infections and catheterized patients—who may have low concentrations of bacteria that can advance to greater concentrations—are significantly lower than 105 cfu/mL [59]. Agreed

Conclusion:

The majority of individuals with simple acute cystitis have clinically simple cases, and other than urinalysis, they do not need any further laboratory tests. However, for a certain proportion of patients, a clear diagnosis of UTI may not be possible based only on the clinical history and physical findings. Laboratory testing are required for those patients as well as those with complex UTIs in order to diagnose and offer precise information about the identity and antimicrobial susceptibility pattern of bacteria. The technique of collection must be taken into consideration for both the laboratory diagnosis and the clinical diagnosis of laboratory test results; physicians should indicate the method of collection on test request forms. Urinalysis is the least useful laboratory test available; it is not a substitute for culture, but it is useful in ruling out bacteriuria. Even though cultures can detect pathogens, accurate interpretation of the results of these tests necessitates clinical data, which is typically only available to clinicians. In order to maximize patient care, we hope that doctors specialising in infectious diseases will recognize the advantages and disadvantages of the laboratory-based diagnostic studies for UTIs that have been reexamined in this article. They should also integrate this knowledge with the most recent treatment guidelines [65].

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