Research Article

Comparison of various screening methods for presumptive diagnosis of significant bacteriuria

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Abstract

Background: Urinary tract infection is a common source of bacterial infection among people of any age. Urinalysis is one of the important and useful urological tests for diagnosis of the infection. Microscopic examination of urine, catalase test, and the dipstick urinalyses (leukocyte esterase test and nitrite test) are common tests used for detecting bacteriuria and pyuria. Although culture is the gold standard method for diagnosis of urinary tract infection, the culture is an expensive and time-consuming method.

Objective: (1) To compare dipstick urinalysis with microscopic urinalysis, (2) to compare dipstick and microscopic urinalyses results with urine culture results, by calculating performance characteristics of dipstick tests, and (3) to compare catalase test with urine culture results.

Materials and Methods: The 1,000 urine specimens were processed by using dipstick and microscopic urinalyses and cultured. Reagent strips reading and microscopic examination were included in laboratory urinalysis in this study.

Result: Of 1,000 urine samples of patients, 186 (18.6%) patients revealed urine cultures with significant bacteriuria (10^5 colonies/mL or greater). Sensitivity and specificity of microscopic urinalysis bacteriuria were 96.77% and 98.52%, respectively. Whereas, in dipstick urinalysis, sensitivity and specificity of nitrite test were 90% and 97% and, in leukocyte esterase test, they were 87% and 95%, respectively. Sensitivity and specificity of catalase test for bacteriuria were 88.63% and 75.86%, respectively.

Conclusion: Dipstick test could be used more effectively as office procedure in rural areas where laboratory facility for microscopy and culture is not available for diagnosis of urinary tract infection.

KEY WORDS: Dipstick, urine microscopy, catalase test, urine culture

Introduction

Urinary tract infection (UTI) is an important health-care problem affecting millions every year. It is more common in female than male subjects.[1] Evaluation of suspected UTI includes history, physical examination, and laboratory investigations. Urine analysis for the presence of pus cells, bacteria, and culture are important in the adequate management of UTIs. Processing of specimens at clinical microbiology laboratory consists of urine for culture and sensitivity testing.[2,3]

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Urine samples constitute a major proportion of the samples tested in routine diagnostic laboratories. Although the urine culture is used as the reference standard to determine the presence or absence of UTI, the culture is an expensive and time-consuming method. Substituting a urine dipstick test or urine microscopy for a hospital laboratory urinalysis may be less time consuming and less expensive.[4] The leukocyte esterase (LE) test is a semiquantitative test that detects the neutrophil-specific esterase activity released from degraded white blood cells. The nitrite reduction test detects nitrite

produced by urinary bacterial pathogens, and nitrites are not found in urine normally but usually result when urinary bacteria reduce nitrates to nitrites; many gram-negative and gram-positive bacteria are capable to do so. A positive dipstick nitrite test indicates that those organisms are present insignificant numbers (more than 100,000/mL). The objectives of the study were: (1) to compare dipstick urinalysis with microscopic urinalysis, (2) to compare dipstick and microscopic urinalysis results with urine culture results, by calculating performance characteristics of dipstick tests, and (3) to compare catalase test with urine culture results.

Materials and Methods

Collection of the Specimens

The 1,000 freshly morning (midstream) urine specimens, collected under sterile conditions as far as possible, were studied. All samples were completely processed within 1–2 h after arrival, to avoid overgrowth of any contaminating bacteria. Specimens containing squamous epithelial cells were not excluded from analysis because other investigators have found that the presence of squamous cells does not affect the diagnostic accuracy of the test.[5]

Urine Dipstick Chemical Analysis

A complete urinalysis included physical, chemical, and microscopic examinations. Reagent strips for urinalysis have been used in our routine laboratory for chemical examinations. The strips included reagent pads for assessment of urobilinogen, bilirubin, ketone, blood, protein, nitrite, LE, glucose, specific gravity, and pH. The LE measurement was read after 2 min and recorded as negative, trace, small (1+), moderate (2+), or large (3+). The nitrite measurement was read at 60 s and recorded as negative or positive.

Microscopic Urinalysis

Urine was sedimented by centrifuging 8.5 mL of patient's urine for 5 min at 1000 × g. After decanting the supernatant, the sediment was thoroughly mixed, a drop of it was placed on a glass slide, and a coverslip was applied. This process concentrates the formed elements in urine by about 35-fold. After examining the content of 10–15 microscopic fields at 10× (low-power field) and 40× (high-power field), the average number of formed elements were noted per number of fields examined.

Catalase test

Many organisms causing UTI contain the enzyme catalase. A positive reaction occurs when urine is mixed with hydrogen peroxide, causing the release of oxygen. The presence of catalase may be not only owing to bacteria but also to erythrocytes, WBC, or kidney cells. Therefore, this test is not specific for bacteria; however, the presence of these other cells may also indicate abnormal findings.

Urine Culture

Of 1,000 urine samples examined, 186 (18.6%) samples gave a growth of 105 or more organisms per milliliter ("culture-positive" samples). The remaining 814 samples were reported as "culture-negative" samples.

Result

A total of 1,000 urine samples were submitted for routine examination, bacterial culture, and dipstick tests (nitrite, LE, and pH). Of 186 culture-positive samples, 129 (69%) were female and 57 (31%) male subjects.

The majority grew *Escherichia coli* [109 (58.60%)], followed by *Klebsiella* sp. [50 (26.88%)], Pseudomonas sp. [16 (8.6%)], *Proteus* sp. [6 (3.22%)], *Acinetobacter* sp. [3 (1.7%)], and *Citrobacter* sp. [2 (1.07%)].

Of the 1,000 specimens, 686 (68.6%) were clear and 314 (31.4%) classified as turbid, and of them, 186 samples were positive for urine culture. Of 186 urine samples, 179 showed alkaline pH and 7 acidic pH.

In this study, urine samples were examined for epithelial cells, leukocytes, red blood cells, casts, crystals, and bacilli in microscopic examination. Dipstick analysis showed the following numbers of positive (trace or greater) results for nitrite [168 (90%)] and LE [162 (87%)] of 186 culture-positive samples.

Table 1 shows, in dipstick test, of 186 culture-positive, 168 (90%) were positive for nitrite test, and 18 were negative for nitrite test. A total of 162 (87%) samples were positive and 24 negative for LE test and 179 (96%) samples showed alkaline and 7 (3%) acidic pH.

Table 2 shows total of 160 samples were tested for catalase test, of which, 67 were positive for catalase test. Of these 67 samples, 39 (58%) were positive for culture examination and catalase test, and 28 (42%) were positive for only catalase test.

Discussion

Of 186 culture-positive, 168 (90%) gave nitrite test positive, which belong to Enterobacteriaceae group, while 18 (10%) were negative for nitrite test from other than Enterobacteriaceae group, which do not convert nitrates into nitrites. LE tests showed 162 samples to be positive and 24 negative, which is mainly because of the presence of significant levels of protein or glucose, high specific gravity, and certain drugs. Thirty-six samples had given positive for LE, and negative for urine culture may be owing to prostatitis neoplasia of the renal tract, renal calculi, catheterization, renal tuberculosis, and prior antimicrobial chemotherapy. A total of 179 samples showed alkaline pH that may be owing to UTI, in sulphonamide therapy, in the treatment of salicylate poisoning, use of a diet high in citrus fruits, and vegetables, and seven showed

Table 1: Comparison of results of urine culture, nitrite test, LE test, and urine microscopy

Urine culture	Nitrite test		LE test		Urine microscopy (pus cells and bacteria)	
	Positive	Negative	Positive	Negative	Positive	Negative
Positive (186), *n* (%)	168 (90)	18 (10)	162 (87)	24 (13)	184 (98)	2 (2)
Negative (814)	24	790	36	778	22	792

Table 2: Comparison of results of culture and catalase test

Culture	Catalase test	No. of samples (%)	Comment
Positive	Positive	39 (24)	True positive
Negative	Positive	28 (18)	False positive
Positive	Negative	5 (3)	False negative
Negative	Negative	88 (55)	True negative

acidic pH owing to meat protein in diet, some fruits such as cranberries, and ammonium chloride.

Of the 160 samples tested for catalase test, 67 were positive for catalase test. Of 67 samples, 39 (24%) were positive for culture examination and catalase test owing to the presence of leukocytes, 28 (18%) catalase positive and negative for culture, likely to be owing to the presence of erythrocytes and leukocyte and kidney cells. The presence of these cells may also indicate abnormal findings, with the sensitivity and specificity of catalase test to be 88.63% and 75.86%, respectively. Catalase is found in most bacteria that causes UTI (but not streptococci) and seen associated with somatic cells (leukocytes and erythrocytes). In most instances, false-negative catalase reactions (significant bacteriuria present) were associated with a cellular urine sample. Because the presence of bacteria without pyuria may be indicative of contamination, the failure of the catalase test in such specimens may be irrelevant in the clinical setting.

In this study, dipstick test, microscopic urinalysis, and catalase test results were compared with urine culture results, which were used as the gold standard method for diagnosis of UTI but present the disadvantage of taking at least 48 h to give a result. More rapid methods of UTI diagnosis are, therefore, desirable. Use of dipsticks, catalase test, and microscopic urinalysis instead of urine culture may decrease patient time and the cost of testing.

The most widely used rapid tests are dipstick tests. Dipstick tests have the advantage of being quick and easy to perform and can be carried out in primary care giving an immediate result. But, false-positive and false-negative rates are significantly higher when compared with the microscopic examination. In dipstick analysis, urinary protein excretions in excess of 500 mg/dL and urinary glucose excretions in excess of 2 mg/dL may diminish the intensity of the reaction color as can cephalexin and gentamicin if administered in high daily doses or boric acid if used as a preservative. The nitrite test depends on the conversion of nitrates into nitrites by bacteria in the bladder. It requires an incubation period of several hours in the bladder and, so, is best performed using an early morning urine sample. Unfortunately, some organisms, especially gram-positive bacteria, do not convert nitrates into nitrites.[3]

Microscopic examination of urine samples for leukocytes, erythrocytes, or bacteria is considerably more time consuming and labor intensive than the dipstick method.[6] Microscopy of the urine is recommended in textbooks for the diagnosis of UTIs. However, it is reported that less than one-third of general practitioners had a microscope; this instrument also appears to be rarely found on the modern hospital wards.[3] In the study, accuracy of microscopic examination was higher than those of dipstick test.

Catalase is found in most bacteria that cause UTI (but not streptococci) and in associated somatic cells (leukocytes and erythrocytes). Rapid diagnosis or to rule out UTI is valuable for both catalase test and dipstick test, to the general practitioner and to the hospital physician. Both tests may be performed when a very rapid conclusion was desired.

The study has suggested that the sensitivity of catalase test (89%) is higher than the sensitivity of LE test (87%), and the specificity of LE test (95%) is higher than the specificity of catalase test (75.86%), while sensitivity (90%) and specificity (97%) of nitrite test is higher than both catalase test and LE test. Both catalase test and dipstick test may be used for rapid diagnosis. Therefore, because urine culture is an expensive test, nitrite and leukocyte in dipstick or leukocyte, erythrocyte, and bacteria in catalase test may be guiding analytes before culture.

Limitation

Although 1,000 samples were to be taken for the study, of them, only 186 patients showed UTI. Because the sample size is small, larger number of samples is required for further confirmation.

Conclusion

Gold standard for diagnosis of UTI remains urine culture positive for significant bacteriuria. Dipstick test using LE and/or nitrite is useful as a screening test in the office setup and especially for areas where laboratories facility is not available.

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