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Analysis of the diagnostic value of fluorescence rapid on-site evaluation compared with bacterial culture in urinary tract infection: a retrospective study

Analiza dijagnostičke vrednosti brze procene na licu mesta fluorescentnom mikroskopijom u poređenju sa bakterijskom kulturom kod infekcije urinarnog trakta: retrospektivna studija

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Abstract

Background/Aim. Prompt and precise detection of urinary tract infections (UTIs) is crucial for timely antibiotic administration and improved treatment outcomes. The aim of the study was to analyze the diagnostic efficacy of fluorescence rapid on-site evaluation (ROSE) compared to bacterial culture (BC) and to evaluate its clinical applicability for identifying UTIs. **Methods.** This retrospective study included 240 inpatients with clinically indicated UTIs evaluated between October 2024 and March 2025. All urine specimens were analyzed using both fluorescence ROSE testing and BC, with the latter serving as the reference standard. Diagnostic metrics–such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy–were calculated. Receiver operating characteristic (ROC) curve analysis was performed to determine the area under the curve (AUC). **Results.** BC revealed 179 (74.58%) positive cases. Fluorescence ROSE demonstrated a sensitivity of 95.53%, specificity of 85.25%, PPV of 95.00%, and NPV of 86.67%, resulting in an overall diagnostic accuracy of 92.92%. The ROC analysis produced an AUC of 0.90 (95% confidence interval: 0.86–0.94). The misclassification rate was minimal at 7.08%. *Escherichia coli* was the primary pathogen, constituting 54.19% of isolates. Furthermore, fluorescent ROSE significantly decreased diagnostic turnaround time compared to traditional culture. **Conclusion.** Fluorescence ROSE has improved diagnostic precision and fast detection capabilities for UTIs. As an adjunct to BC, it may improve early identification and facilitate rapid antibiotic therapy, especially in clinical settings requiring a swift response.

Keywords:
bacteriological techniques; diagnosis; microscopy, fluorescence; urinary tract infections.

Apstrakt

Uvod/Cilj. Brzo i precizno otkrivanje infekcija urinarnog trakta (*urinary tract infections* – UTI) ključno je za blagovremenu primenu antibiotika i poboljšanje ishoda lečenja. Cilj rada bio je da se analizira dijagnostička efikasnost brze procene na licu mesta (*rapid on-site evaluation* – ROSE) fluorescentnom mikroskopijom, u poređenju sa bakterijskom kulturom (BK) i da se proceni njena klinička primenljivost za identifikaciju UTI. **Metode.** Retrospektivnom studijom obuhvaćeno je 240 hospitalizovanih bolesnika, kojima je od oktobra 2024. do marta 2025. godine klinički utvrđena UTI. Svi uzorci urina analizirani su metodom ROSE fluorescentnom mikroskopijom i BK (koja je služila kao referentni standard). Izračunati su dijagnostički pokazatelji, kao što su osetljivost, specifičnost, pozitivna prediktivna vrednost (PPV), negativna prediktivna vrednost (NPV) i ukupna tačnost. Da bi se utvrdila *area under the curve* (AUC), sprovedena je analiza *receiver operating characteristic* – ROC krive. **Rezultati**. Korišćenjem BK, otkriveno je 179 (74,58%) pozitivnih slučajeva. Metoda ROSE fluorescentnom mikroskopijom pokazala je osetljivost 95,53%, specifičnost 85,25%, PPV 95,00% i NPV 86,67%, uz ukupnu dijagnostičku tačnost od 92,92%. Analizom ROC krive dobijena je AUC 0,90 (95% *confidence interval*: 0,86–0,94). Stopa pogrešne klasifikacije bila je minimalna i iznosila je 7,08%. *Escherichia coli* bila je primarni patogen, čineći 54,19% izolata. Pored toga, korišćenjem metode ROSE fluorescentnom mikroskopijom značajno je skraćeno vreme dijagnostičke obrade u odnosu na tradicionalnu kulturu. **Zaključak.** Korišćenjem metode ROSE fluorescentnom mikroskopijom, dijagnostička preciznost i mogućnosti brzog otkrivanja UTI bili su poboljšani. Kao dodatak BK, ova metoda može

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poboljšati ranu identifikaciju i olakšati brzu antibiotsku terapiju, posebno u kliničkim uslovima, gde je potreban brz odgovor.

Ključne reči:
bakteriološke tehnike; dijagnoza; mikroskopja, fluorescencija; urinarni trakt, infekcije.

Introduction

Urinary tract infection (UTI) is a common, clinically encountered infectious disease of the urinary system. The timely and accurate diagnosis of UTI plays a crucial role in the rational selection of antibiotics, improvement of patient prognosis, reduction of complications, prevention of bacterial resistance, and other related aspects [1].

Rapid diagnosis enabled by accurate laboratory tests is critical for improving clinical outcomes in infectious diseases. The diagnostic workflow for infectious diseases integrates clinical history, physical examination, radiographic findings, routine laboratory data, and targeted microbiological/parasitological analyses [2].

Although traditional bacterial culture (BC) methods are recognized as the gold standard for diagnosing UTIs [3], they have multiple prominent limitations that restrict clinical application. First, the testing cycle is long, usually requiring 18–24 hrs of incubation and even longer for slow-growing pathogens, which delays the confirmation of diagnosis and the initiation of targeted treatment. Historically, the major drawback of conventional microbiological diagnostics has been the long turnaround time. Nevertheless, BC remains the undisputed gold standard against which all novel rapid assays are validated. While pathogen isolation *via* culture requires prolonged incubation, it remains the only method that enables complete serological, molecular, and biochemical identification of etiologic agents as well as antimicrobial susceptibility testing, which is irreplaceable for clinical treatment guidance. Second, the operation is relatively complex, involving inoculation, incubation, colony identification, and drug-sensitivity testing, which requires professional technical personnel and strict laboratory conditions [4, 5]. It cannot meet the needs of rapid diagnosis of acute infections: in cases of severe acute UTI (such as acute pyelonephritis with high fever), delays in culture results may lead to disease progression and severe complications [6]. Third, the method is susceptible to false-negative (FN) results. For instance, when the bacterial load in the urine sample (US) is low, and the pathogen is difficult to culture (such as some fastidious bacteria), this may lead to missed detection [7].

Microscopic examination—encompassing light, fluorescence, and electron microscopy—enables direct detection of microorganisms in clinical specimens and remains an irreplaceable rapid tool in microbiological diagnosis [8]. Common microscopic preparations include wet mounts, hanging-drop preparations, dark-field mounts, and stained smears. Wet mount techniques preserve microbial viability and allow real-time observation of leukocytes (indicating inflammation), erythrocytes, parasites, and motile bacteria. Non-specific stains, differential stains (e.g., Gram stain), and fluorescent dyes enhance visualization of pathogens. The Gram stain, despite moderate sensitivity, provides rapid morphological information about bacterial shape, arrangement, and cell wall properties. Fluorescent stains (non-antibody-based) have become increasingly valuable in rapid microbiological screening [9]. A major limitation of all manual microscopic methods is their high dependence on specialized expertise [10].

With the continuous advancement of medical technology, fluorescence rapid on-site evaluation (ROSE) has emerged as a new rapid detection technique, offering novel perspectives for the diagnosis of UTIs [11].

Compared with traditional chemical staining (e.g., Gram stain) and wet-mount microscopy, fluorescent ROSE provides higher signal intensity and contrast, reduces reliance on subjective microscopic judgment, shortens reading time, and lowers the requirement for extensive on-site expert experience. It enables more sensitive detection of low-burden pathogens and clearer distinction between microbial structures and cellular debris, thus improving differentiation between infection and contamination [12].

The aim of the study was to analyze diagnostic data of 240 clinically suspected UTI patients, comparing the diagnostic performance of fluorescence ROSE and BC in order to provide a basis for the rational application of fluorescence ROSE in clinical practice.

Methods

The study protocol was approved by the Ethics Committee of Beijing Chaoyang Hospital, Capital Medical University, Beijing, China (No. 2452/UTI/08/2024, from October 12, 2024). This retrospective study collected and analyzed clinical data and inspection results from patients who were admitted to the hospital and underwent relevant inspections.

Research subjects

A total of 240 inpatients with clinically suspected UTI, admitted to our hospital from October 2, 2024, to March 31, 2025, were selected. USs were collected from these patients the morning after admission, and all samples were submitted for microbiological examination as specimens.Researchers could trace the entire case history of patients from the beginning of data collection onwards.

Inclusion and exclusion criteria

Inclusion criteria were as follows: patients with typical acute UTI symptoms, including frequent urination, urgency, dysuria, lower abdominal pain, and fever (body temperature ≥ 38.5 °C); routine urine examination demonstrating elevated white blood cells (WBC) count [≥ 10 cells *per* high-power

field (HPF)] or positive nitrite test; adult patients aged 18–80 years; patients with first-episode acute UTI or acute exacerbation of chronic UTI diagnosed with complete clinical data such as detailed medical history, physical examination results, laboratory test results, and treatment records; USs collected prior to the initiation of antibiotics (confirmed by clinical medication records); diagnostic basis consistent with the diagnostic criteria for UTI in the Guidelines for the Diagnosis and Treatment of Urinary Tract Infections (2023 Edition) [13].

Exclusion criteria were the following: patients with infections in other sites (such as respiratory tract infection, abdominal infection) or systemic infections (such as sepsis); patients who used antibiotics within 7 days before sampling; pregnant or lactating women; patients with severe heart, liver, kidney, or other organ dysfunction or immune system diseases (such as rheumatoid arthritis, acquired immune deficiency syndrome – AIDS); patients with urinary tract anatomical abnormalities (such as hydronephrosis, ureteral stenosis) or recent urinary tract surgery (within 1 month); patients with chronic asymptomatic bacteriuria without acute infection symptoms; USs with obvious contamination (such as visible turbidity, foreign bodies) or improper collection (such as non-midstream urine).

Research methods

All USs underwent fluorescence ROSE testing and microbial culture, with the latter serving as the gold standard for evaluating the diagnostic performance of fluorescence ROSE. Each US was divided into two parts: one part was used for fluorescence ROSE detection and the other for microbial culture, to compare the diagnostic indicators of the two methods.

Fluorescence rapid on-site evaluation technique

The techniques for collecting and analyzing USs were performed as follows. First, the collected midstream US was placed in a centrifuge and spun at 2,500 revolutions *per* minute (rpm) for 10 min. Next, a small amount of the precipitate was removed, spread evenly on a glass slide, and allowed to air-dry naturally. Finally, the sample was stained for 5 min using a commercial fluorescence staining kit.

Under a fluorescence microscope, an artificial intelligence (AI) algorithm automatically scans and identifies microorganisms by analyzing morphological features such as size, shape, and fluorescence intensity, enabling preliminary classification of common pathogens (e.g., bacilli vs. cocci, Gram-negative vs. Gram-positive-like patterns).

After AI identification, attending physicians with professional microbiology experience manually review all images. They confirm pathogen morphology and inflammatory cell infiltration, and distinguish true infection from sample contamination based on cell quantity, distribution, and background characteristics. The physicians also observe cell morphology, microbial morphology, and the presence of inflammatory cell infiltration to determine whether bacteria, fungi, or other pathogens are present. Fluorescence ROSE mainly provides preliminary morphological classification rather than definitive species-level identification. Final species confirmation and antimicrobial susceptibility testing still rely on conventional BC. The result is judged positive if specific fluorescent-labeled pathogens are detected and negative otherwise.

Bacterial culture

The USs were inoculated onto blood agar plates and China blue lactose agar media with an inoculation volume of 100 μL, followed by incubation at 35 °C, in a 5% CO_2 incubator for 18–24 hrs. Colony growth was then observed: if the colony count was $\geq 10^5$ colony-forming units (CFU)/mL, bacterial identification and antibiotic sensitivity testing were performed using an automatic microbial identification system (VITEK® 2 Compact system, bioMérieux, Marcy-l'Étoile, France). If the colony count was $< 10^5$ CFU/mL, the culture was considered negative (excluding contaminated colonies). BC results served as the gold standard for UTI diagnosis, which was defined as positive if pathogenic bacteria were identified and negative otherwise.

Observation indicators

Primary indicators were sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of fluorescence ROSE (with BC as the gold standard). Secondary indicators referred to the positive detection rates of the two methods and the detection times (from sample collection to result reporting) for fluorescence ROSE and BC.

Evaluation methods

Diagnostic performance metrics, including sensitivity, specificity, PPV, and NPV, were calculated using standard formulas: Sensitivity = true positive (TP) / [TP + FN] × 100%; specificity = true negative (TN) / [TN + false positive (FP)] × 100%; PPV = TP / (TP + FP) × 100%; NPV = TN / (TN + FN) × 100%; TP: fluorescence ROSE positive + BC positive; FP: fluorescence ROSE positive + BC negative; TN: fluorescence ROSE negative + BC negative; FN: fluorescence ROSE negative + BC positive.

Statistical analysis

Data were analyzed using SPSS Statistics version 27. Categorical variables were represented as frequencies and percentages and analyzed using the χ^2 test. Diagnostic metrics such as sensitivity, specificity, PPV, and NPV were derived from the contingency table, along with their respective 95% confidence intervals (CIs). The concordance among fluorescence ROSE and BC was measured using the Kappa statistic. A two-tailed p-value < 0.05 was deemed statistically noteworthy.

Results

Patient demographic and clinical characteristics

A total of 240 inpatients with clinically suspected UTI were included in this retrospective study (Table 1). The mean age was 56.8 ± 15.2 years (range: 18–80 years). Females accounted for 61.25% of the study population.

The most common presenting symptoms were urinary frequency/urgency (73.33%), dysuria (62.08%), and lower abdominal pain (42.50%). Fever (≥ 38 °C) was observed in 31.67% of patients. Regarding comorbidities, 32.50% had diabetes mellitus (DM) and 35.00% had hypertension. Indwelling urinary catheters were present in 23.75% of patients. Elevated urine WBCs (≥ 10 cells/HPF) were detected in 88.75% of cases, and nitrite positivity was observed in 55.83%.

Diagnostic performance and receiver operating characteristic curve analysis

Using BC as the reference standard, fluorescence ROSE correctly identified 171 TP and 52 TN cases, with 9 FPs and 8 FNs among the 240 patients (Table 2). Accordingly, fluorescence ROSE demonstrated a sensitivity of 95.53% (171/179) and a specificity of 85.25% (52/61). The PPV was 95.00%, while the NPV reached 86.67%. The overall diagnostic accuracy was 92.92% (223/240), indicating high reliability in detecting UTIs. Receiver operating characteristic (ROC) curve analysis produced an area under the curve (AUC) of 0.90 (95% CI: 0.86–0.94) (Figure 1). Furthermore, the Youden index was 0.81. Collectively, these results indicate that fluorescence ROSE exhibits high overall diagnostic performance according to established thresholds for clinical diagnostic tests.

Distribution of uropathogens identified by bacterial culture

Among the 179 (74.58%) culture-positive USs, *Escherichia coli* was the predominant pathogen, accounting for 54.19% of all isolates. This was followed by *Klebsiella* spp. (17.32%) and *Enterococcus* spp. (11.73%). Less frequently isolated organisms included *Proteus* spp. (6.70%) and *Pseudomonas aeruginosa* (5.03%), while other pathogens collectively represented 5.03% of cases (Table 3).

Overall, Gram-negative bacteria constituted the majority of isolates, highlighting their primary role in the etiology of UTI within the study population. The predominance of *Escherichia coli* aligns with well-established epidemiological patterns of UTIs and supports the external validity of the present findings.

Table 1

Baseline demographic and clinical characteristics of patients (n = 240)

Characteristic	Value
Age, years	56.8 ± 15.2
Age ≥ 65 years	81 (33.75)
Gender	
male	93 (38.75)
female	147 (61.25)
Body temperature ≥ 38 °C	76 (31.67)
Dysuria	149 (62.08)
Urinary frequency/urgency	176 (73.33)
Lower abdominal pain	102 (42.50)
Indwelling urinary catheter	57 (23.75)
Diabetes mellitus	78 (32.50)
Hypertension	84 (35.00)
Recurrent UTI history	67 (27.92)
Elevated urine WBC (≥ 10 cells/HPF)	213 (88.75)
Positive nitrite test	134 (55.83)

n – number of patients; UTI – urinary tract infection; WBC – white blood cells; HPF – high-power field.
Values are given as numbers (percentages) or mean ± standard deviation.

Table 2

Diagnostic performance of fluorescence ROSE compared with bacterial culture

Fluorescence ROSE	Bacterial culture		Total
	positive	negative	
Positive	171 (TP)	9 (FP)	180
Negative	8 (FN)	52 (TN)	60
Total	179	61	240

ROSE – rapid on-site evaluation; TP – true positive; FP – false positive; FN – false negative; TN – true negative. Values are given as numbers.

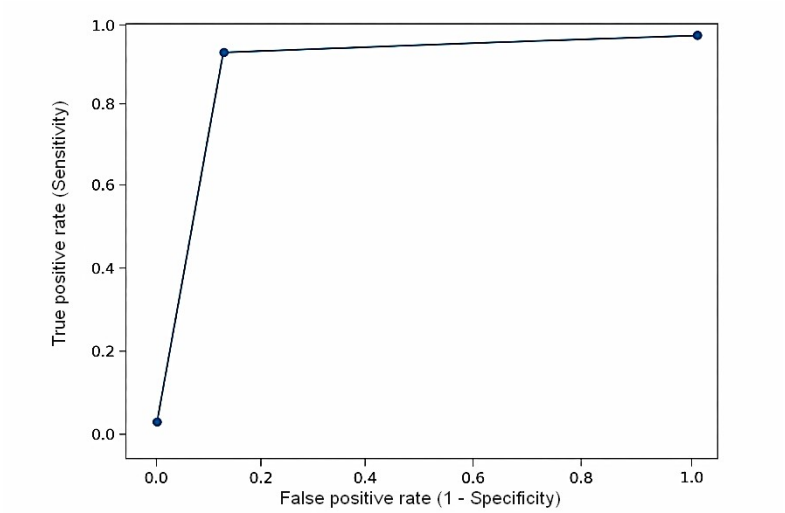

Fig. 1 – Receiver operating characteristic (ROC) curve for fluorescence rapid on-site evaluation (ROSE) in the diagnosis of urinary tract infection.

Table 3

Distribution of uropathogens identified by bacterial culture (n = 179)

Pathogens	Value
Escherichia coli	97 (54.19)
Klebsiella spp.	31 (17.32)
Enterococcus spp.	21 (11.73)
Proteus spp.	12 (6.70)
Pseudomonas aeruginosa	9 (5.03)
Other	9 (5.03)

n – number of patients.
All values are given as numbers (percentages).

False-positive and false-negative analysis

Among the 240 samples, 9 (5.00%) cases were FPs and 8 (3.33%) cases were FNs (Table 2), resulting in an overall misclassification rate of 7.08%.

Slide preparation lasted for 3.0 ± 0.3 min. The AI image reading requires approximately 4.0 ± 0.5 min.

Clinical utility

Fluorescence ROSE significantly reduced diagnostic turnaround time compared with conventional BC. The average processing time was approximately 7 min, whereas culture required approximately 24 hrs, representing a reduction of more than 95%.

The rapid availability of microbiological information may support earlier clinical decision-making and timely initiation of antimicrobial therapy. Fluorescence ROSE may therefore serve as a useful adjunct to conventional culture, particularly in clinical settings requiring prompt diagnosis.

Discussion

Fluorescence ROSE is a new type of rapid microbial detection technology that combines fluorescence staining, AI image recognition, and microscopic observation [14]. Its core principle is to centrifuge USs to enrich pathogens, perform specific fluorescence staining on the precipitates, and then use AI algorithms for automatic recognition and detection under a fluorescence microscope with physician review to confirm the presence of pathogens [15]. Fluorescence ROSE offers multiple technological advantageous features.

Although slide preparation and image analysis require only several minutes, the complete reporting workflow in clinical practice is generally completed within 2–4 hrs. This timeline is substantially shorter than the 18–24 hrs required for BC [16]. Furthermore, the high sensitivity of specific fluorescence labeling allows for the effective identification of pathogens even at low concentrations, thereby reducing the rate of missed detections [17]. Additionally, the operation is relatively simple and can be completed entirely in a laboratory [18]. It requires neither complex equipment nor long-term cultivation, allowing it to provide rapid, preliminary pathogen identification (such as distinguishing between bacteria and fungi) to help clinicians formulate initial, targeted treatment plans [19]. Consequently, in clinical practice, fluorescence ROSE is mainly used for rapid screening of acute infectious diseases, especially for scenarios requiring urgent diagnosis and treatment (such as emergency UTI patients and severe infection patients in intensive care units), to compensate for the limitations of BC in rapid diagnosis [20].

Comorbidities such as DM and indwelling urinary catheters are known to alter the urinary microenvironment and increase the risk of colonization, which may influence both microbiological culture yields and rapid test performance. Although these factors were recorded as baseline characteristics, the present study did not perform subgroup analyses due to limited sample size.

By analyzing USs from 240 clinically suspected acute UTI patients, this study found that fluorescence ROSE had high sensitivity (95.53%) and good specificity (85.25%) in detecting common UTI pathogens, which is consistent with the research results of Zhang et al. [20] and Trang et al. [21]. Wang et al. [22] applied fluorescence ROSE to the diagnosis of pulmonary infections and found that its sensitivity for pathogen detection was 93.1%, which is close to the sensitivity observed in this study, indicating stable performance across different infectious diseases. Mirham et al. [23] reported that slide preparation can be completed within 4 min, which is comparable to the 3.0 ± 0.3 min reported in this study. Chen et al. [24] noted that AI image reading requires approximately 4–5 min, consistent with the 4.0 ± 0.5 min observed in our experiment. These findings confirm the rapid detection capability of fluorescence ROSE. Fluorescence ROSE demonstrated excellent sensitivity and specificity, achieving an overall diagnostic accuracy of 92.92% and an AUC of 0.90, signifying exceptional discriminative capacity for distinguishing infected from non-infected patients. The Youden index of 0.81 indicates a robust equilibrium between sensitivity and specificity. The enhanced sensitivity suggests that fluorescence ROSE may be particularly effective as a rule-out test for patients with suspected UTIs, while its commendable specificity supports its use as a supplementary diagnostic tool alongside traditional BC.

The high sensitivity of fluorescence ROSE may be attributed to two main reasons. First, pathogens in urine samples are relatively homogeneous, facilitating morphological recognition under fluorescence microscopy [20]. Second, fluorescence staining enhances pathogen visualization, particularly when bacteria adhere to epithelial cells or are phagocytosed by leukocytes [25]. Regarding specificity, fluorescence ROSE uses direct immunofluorescence technology to bind specifically to microbial structures, generating characteristic fluorescence signals under specific wavelengths [26], which improves diagnostic precision. However, non-standardized sample collection or processing, such as contamination or suboptimal preparation, may lead to FP and FN results [27], which may partially explain the occurrence of FP cases observed in this study.

Urine BC remains the gold standard for UTI diagnosis, allowing pathogen identification and antimicrobial susceptibility testing [3]. In this study, BC identified 179 positive cases, of which 171 were consistent with fluorescence ROSE results, demonstrating good agreement ($\kappa = 0.803$). However, BC requires prolonged incubation, and empirical antibiotic therapy is often initiated before culture results are available, potentially contributing to inappropriate antibiotic use and antimicrobial resistance [28]. Fluorescence ROSE provides preliminary pathogen information within a short time frame, supporting earlier adjustment of empirical therapy [29].

A significant discovery of this investigation is the considerable decrease in diagnostic turnaround time. Fluorescence ROSE produced results in minutes compared to the roughly 24 hrs required for bacterial growth, indicating a reduction exceeding 95%. Timely pathogen identification may enable rapid initiation of antimicrobial therapy, enhance antibiotic stewardship, and reduce unnecessary exposure to broad-spectrum antibiotics. This swift diagnostic skill is especially crucial in emergency and inpatient settings where prompt treatment decisions are essential.

Compared with Wu et al. [30], fluorescence ROSE in this study demonstrated higher sensitivity but slightly lower specificity, possibly due to differences in staining protocols and AI recognition algorithms. Zhou et al. [31] emphasized that rapid diagnostic technologies must balance sensitivity and specificity, and further optimization of staining techniques and AI algorithms may improve specificity. The investigation has several strengths. Initially, it offers an extensive examination of fluorescence ROSE using various diagnostic metrics, including sensitivity, specificity, predictive values, ROC analysis, agreement testing, and misclassification evaluation [32]. Secondly, it mirrors actual clinical practice by examining hospitalized patients with probable UTIs [1]. These aspects augment the clinical relevance and translational significance of the results.

In this study, subgroup analysis by individual pathogens was not performed, so diagnostic differences among specific organisms remained unclear, in contrast to the differentiation observed in some other infections [33].

Limitation of the study

The study has several limitations. First, as a single-center retrospective study with a limited sample size (240 cases), it may introduce selection bias and limit generalizability. Second, subgroup analysis of individual pathogens was not performed. Third, special populations such as children, pregnant women, and patients with complicated infections were not included, and further validation is required [34]. Fourth, a detailed analysis of FP mechanisms was not conducted. FP results may be related to the detection of nonviable bacteria, cellular debris, and specimen contamination that does not yield growth in culture. Suppressed bacterial viability from prior antimicrobial exposure may also contribute to culture-negative yet fluorescence-positive findings. FN results were infrequent and may be associated with low bacterial load, uneven microbial distribution within the specimen, and technical factors during slide preparation and imaging. The low FN rate supports the utility of fluorescence ROSE as a rapid screening method, while positive findings should be interpreted alongside confirmatory culture testing. Fifth, the impacts of major comorbidities such as DM and indwelling urinary catheters on test performance were not quantitatively analyzed.

To address these limitations, our future research will focus on several key areas. First, we plan to expand the sam-

ple size and conduct multicenter prospective studies to evaluate pathogen-specific diagnostic performance, and include special patient populations. Second, we aim to evaluate pathogen-specific diagnostic performance and optimize AI recognition algorithms to reduce FP rates. Third, we will explore the integration of fluorescence ROSE with molecular diagnostic technologies, such as polymerase chain reaction (PCR), to further enhance diagnostic accuracy. Finally, future studies will assess diagnostic performance in clinical subgroups stratified by DM, urinary catheterization, and other key comorbidities.

Conclusion

Fluorescence ROSE has considerable potential as a rapid adjunctive diagnostic tool that might enhance the early detection and clinical management of UTIs. Fluorescence ROSE demonstrated superior effectiveness in diagnosing urinary tract infection, with elevated sensitivity, commendable specificity, and robust overall precision compared with bacterial culture. The area under the receiver operating characteristic curve validated the model's strong discriminative capacity. Fluorescence ROSE considerably decreased diagnostic turnaround time, enabling swift preliminary microbiological identification and aiding quicker clinical decision-making. While bacterial culture is crucial for definitive pathogen identification and antibiotic susceptibility testing, fluorescence ROSE serves as an effective and reliable screening technique. Integrating it into standard clinical processes may enhance diagnostic efficiency, facilitate the prompt initiation of antimicrobial treatment, and perhaps promote more judicious antibiotic use. Additional multicenter prospective trials are necessary to confirm its wider clinical usefulness.

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Conflicts of interest

The authors declare no conflict of interest.

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