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Urine Culture Performance at a Tertiary Hospital in Dar es Salaam, Tanzania: A Call for Diagnostic Stewardship to Improve Urinary Tract Infection Management

Dominic S. Renatus[a], Jackline O. Nnko[a], Edesio H. Makaria[b], George P. Judicate[c], Salim S. Masoud[a], Mtebe V. Majigo[a], Anjela Charles[a], Zacharia L. Laizer[a]

[a]Department of Microbiology and Immunology, Muhimbili University of Health and Allied Sciences, Dar es Salaam, Tanzania; [b]Department of Clinical Pathology, Muhimbili National Hospital, Dar es Salaam, Tanzania; [c]National Institute of Medical Research, Dar es Salaam, Tanzania.
Correspondence to Dominic S. Renatus (dominicrenatus@gmail.com)

ABSTRACT

Background: Urinary tract infections (UTIs) are often caused by bacterial pathogens that affect the urinary system, including the kidneys, ureters, bladder, and urethra. They can spread to the bloodstream, leading to various clinical symptoms such as fever, flank pain, dysuria, cystitis, and pyelonephritis. Urinary tract infection can impact both males and females, as well as individuals of all ages. However, some urine samples that are accepted and cultured yield non-significant growth results that greatly exceed those of significant growth. We analysed the frequency distribution of urine culture outcomes and their relation to patient characteristics at a tertiary hospital.

Methodology: A retrospective, hospital-based, cross-sectional study was conducted at the Central Pathology Laboratory of Muhimbili National Hospital in Dar es Salaam, Tanzania, from July to August 2024, involving the review of archived urine culture data. Data of patients of all ages ranging from 6 months to 99 years old and both genders who were investigated for UTIs from January to December 2023 were included in the study. Data were collected using a structured data collection tool and analysed using the Statistical Package for the Social Sciences.

Results: Of 3,652 patients tested for UTI by urine culture, 2,189 (59.9%) were female, and 626 (17.1%) were under age 5. Only 828 (22. 7%) had significant bacterial growth detected, while 2217 (60.7%) showed no bacterial growth. Non-significant and mixed growth were observed in 322 (8.7%) and 285 (7.8%) of the participants, respectively. Female patients had higher rates of significant growth (24.4% vs. 20.0%) and non-significant growth (10.7% vs. 5.9%) (P<.001). Conversely, males had a higher frequency of negative cultures (66.8%) than females (56.6%) (P<.001). Patients aged 61 years or older exhibited the highest rate of significant growth (32.2%), with the lowest rate observed in adolescents (5–17 years) at 16.0%. This difference across age groups was statistically significant (P<.001). Non-significant growth was more common among outpatients (11.4%) than in ICUs (3.8%) and inpatients (8.5%) (P<.001).

Conclusion: This study demonstrates a low yield of urine cultures from among the clinically suspected UTI cases, as the majority of the cases were not confirmed microbiologically. It also describes significant differences in culture positivity across sex, age, and healthcare settings, underscoring the need for tailored laboratory and clinical practices.

BACKGROUND

Urinary tract infections (UTIs) are inflammations of the urinary tract, which includes the urethra, urinary bladder, ureters, and the kidneys. They are common among individuals of all ages and genders, presenting with symptoms such as painful urination, increased frequency, discomfort in the suprapubic area, fever, flank pain, chills, vomiting, and nausea.[1] A urine culture confirms the presence of bacteria or fungi in the urine, serving as the definitive diagnosis of a UTI.[2] Laboratory-based diagnostic testing for UTIs constitutes one of the highest-volume categories of clinical microbiology testing performed in healthcare settings today;[3] however, most urinary samples yield negative results.[4] The practice may indicate overutilization of laboratory services or an unnecessary increase in healthcare costs, with either no benefit or a detrimental effect on patient care.[5] In Tanzania, UTI prevalence varies considerably by setting and population. A cross-sectional study of symptomatic outpatients at Morogoro Regional Referral Hospital found a culture-confirmed UTI prevalence of 41% (141/344), with elderly patients (≥60 years) having five times higher odds of infection compared to adolescents.[6] In contrast, a larger study of 2,097 patients with clinical symptoms of UTI conducted across two periods (2019–2020 and 2023) in Mwanza, Tanzania, reported an overall culture-positive UTI prevalence of 22.8% (479/2097), with no significant change in prevalence between the two periods despite the implementation of Tanzania's

National Action Plan on Antimicrobial Resistance.[7] These findings highlight the substantial burden of UTIs in Tanzanian healthcare settings and underscore ongoing concerns regarding antimicrobial resistance among uropathogens in the region.

In most healthcare facilities, empirical antibiotic treatment is initiated before culture results are available, contributing to antibiotic overuse.[8] To address this issue, some healthcare systems have implemented reflex urine culture testing, a strategy that limits urine cultures to cases in which urinalysis results meet specific criteria. This approach enhances diagnostic stewardship and reduces both the number of urine cultures performed and antimicrobial use.[9–11] Diagnostic stewardship is essential for coordinating care efforts, particularly through the earlier integration of laboratory testing into the care process to improve patient management.[12] Diagnostic stewardship initiatives can be implemented across all three stages of laboratory testing: test ordering, test performance, and result interpretation and reporting, thereby supporting the overarching goal of improved patient care.[13]

Several factors may contribute to the low yield of urine cultures, including the underestimation of low-count bacteriuria for certain pathogens. Although bacterial counts of $\geq 10^5$ colony forming units (CFU)/mL are typically considered significant, lower thresholds of $\geq 10^2$–$<10^4$ CFU/mL may be diagnostically important for certain bacteria, such as *S. saprophyticus*.[14] Improper urine collection can result in contamination, leading to non-significant or mixed bacterial growth that complicates the diagnosis of UTIs. Proper sample collection is therefore crucial for diagnostic accuracy.[15] Additionally, the empirical use of broad-spectrum antibiotics before culture can yield false-negative urine culture results and contribute to the development of antibiotic resistance.[16]

The standard operating procedure for urine culture in clinical laboratories follows precise steps to accurately identify pathogens in the urinary tract. In our settings in Tanzania, specimens are carefully collected to minimise contamination and cultured on cystine lactose electrolyte-deficient agar, MacConkey agar, and blood agar.[17] Plates are incubated aerobically, followed by colony counting, Gram staining, and biochemical tests for identification. Antimicrobial susceptibility testing guides treatment decisions, with strict safety and quality control measures ensuring the reliability of results. Interpretation focuses on differentiating significant bacterial growth ($\geq 10^5$ CFU/ml) for a single bacterial type from contamination or non-significant growth ($<10^4$ CFU/ml). Mixed growth suggests contamination, requiring a repeat sample.

Although using a standard operating procedure to process urine for culture ensures accuracy, Elevated rates of non-significant growth impose unnecessary costs and delay patient diagnosis, highlighting the need for more effective screening strategies. Evaluating the ability of urine culture to detect microbiologically confirmed urinary tract infections among clinically suspected cases is vital for better UTI management. This study analyses the performance of urine culture as a diagnostic tool at a tertiary hospital in Dar es Salaam, Tanzania, examining the distribution of culture results in relation to patient characteristics. The findings underscore the need for diagnostic stewardship to optimise urine culture utilisation and improve the clinical management of urinary tract infections.

MATERIALS AND METHODS

Study Design and Settings

A retrospective cross-sectional study was conducted by reviewing the medical records and laboratory results of patients who underwent urine culture testing from January to December 2023. The study was conducted at the Central Pathology Laboratory (CPL) of the Muhimbili National Hospital (MNH) in Dar es Salaam, Tanzania. Muhimbili National Hospital is a referral and university teaching hospital with a capacity of 1,500 beds, treating between 1,000 and 1,200 outpatients and admitting a similar number of inpatients each week. The CPL features microbiology sections, including bacteriology, serology, molecular biology, and tuberculosis.

Study Population

The study population included patients who visited MNH with signs and symptoms of UTI. It comprised both males and females, as well as inpatients and outpatients of all ages from 6 months to 99 years old who had urine cultures at CPL from January to December 2023. However, the study excluded patients with incomplete information and those without reported results.

Sample Size

The sample size was estimated using Kish and Leslie's formula: $n = z^2P(1\text{-}P)/\varepsilon^2$. In this formula, n represents the sample size, Z is the standard normal deviation corresponding to a given statistical significance level ($z = 1.96$, assuming a significance level of 0.05). P represents the proportion of patients with significant bacteriuria, as indicated by a recent study conducted in 2023 in Morogoro, Tanzania ($P = 41\%$).[6] ε is the margin of error, approximately 5% (0.05). Therefore, the minimum sample size was approximately 372. However, all patients who met the inclusion criteria during the study were included to enhance the study's precision. This choice was guided by the ethical use of data, which encourages the utilisation of all available data to enhance scientific knowledge without incurring additional costs or burdening participants.

Data Collection

Data were extracted from Jeeva software, encompassing data from January to December 2023, and their completeness was verified. We collected specific information and recorded it in a data collection form. The data included demographic details, such as age and sex, as well as urine culture results which encompassed four categories; no growth where there was no bacterial growth on the culture media, non-significant growth for growth of 10^4 cfu/ml or less, a mixed growth where there

was growth of more than one bacterium morphotypes on the culture media and significant growth where there was growth of at least 10^5cfu/ml.

Data Analysis

The data were analysed using the Statistical Package for the Social Sciences (SPSS) Version 20. Descriptive analyses were summarised in terms of frequency and proportion. A chi-square test was conducted to illustrate the relationship between patients' characteristics and urine culture result categories. A P value of <.05 was considered statistically significant at a significance level of $\alpha = 0.05$.

Ethical Consideration

The study was conducted in compliance with the Declaration of Helsinki and Good Clinical Practice Guidelines. Ethical approval was obtained from the Senate Research and Publications Committee at Muhimbili University of Health and Allied Sciences, Ref: No. DA.282/298/02L/170. The MNH administration granted permission to access data at the CPL. As the study involved secondary use of routinely collected clinical data, no direct patient contact or intervention was undertaken. Data were accessed only for the approved research purposes and were handled in accordance with applicable principles of data protection, privacy, confidentiality, and responsible secondary use of health data. To protect participant confidentiality, direct personal identifiers, including patient names, were not collected or included in the research dataset; instead, unique patient identification numbers were used for data management and analysis.

RESULTS

Demographic Characteristics of the Study Population.

A total of 3,652 patients were included in the analysis of urine culture results, with the majority, 2,189 (59.9%), being female, and a significant number, 626 (17.1%), being under 5 years old. Adults aged 61 years and above comprise 708 (19.4%). Most patients, 1,819 (49.8%), were from non-intensive care units (ICU), while outpatients comprised 1,303 (35.7%) (Table 1).

Distribution of Urine Culture Results

The results of this study were grouped into four categories: no growth, which occurred at a frequency of 2217 (60.7%); non-significant growth, at 322 (8.8%); mixed growth, at 285 (7.8%); and significant growth, at 828 (22.7%), as shown in Table 2.

Urine Culture Results by Age, Sex, and Service Delivery Location

Patients aged 61 years and older showed the highest proportion of significant growth (32.2%), followed by those aged 36 to 60 years (22.7%). The lowest rate of significant growth was among adolescents aged 5 to 17 years (16.0%). The difference in significant growth across age groups was statistically significant (P<.001). Non-significant growth was highest in the 36 to 60 age group (11.3%), and a moderately significant difference was observed across age categories for non-significant growth (P=.028). Analysis by service delivery location showed that ICU patients had the highest rate of significant growth (36.0%), compared to inpatients (21.8%) and outpatients (18.5%) (P<.001). Patients from the ICU also had the lowest proportion of no growth (52.5%). Non-significant growth was more common in outpatients (11.4%) than in ICUs (3.8%) and inpatients (8.5%) (P<.001). There was no significant difference in the mixed growth of urine culture results based on demographic factors such as sex, age, or service delivery location (Table 3).

TABLE 1: Characteristics of Patients Investigated for Urine Culture from January to December 2023 at Muhimbili National Hospital

Variable	Frequency (n)	Percentage (%)
Sex		
Female	2189	59.9
Male	1463	40.1
Age		
<5	626	17.1
5-17	507	13.9
18-35	831	22.8
36-60	980	26.8
61 and above	708	19.4
Service delivery location		
Intensive care unit	530	14.5
Inpatient	1819	49.8
Outpatient	1303	35.7

Frequency (n) represents the number of participants in each category

TABLE 2: Frequency Distribution of Urine Culture Results from January to December 2023 at Muhimbili National Hospital

Outcome	Frequency (n)	Percentage (%)
Significant growth	828	22.7
No growth	2217	60.7
Non-significant growth	322	8.8
Mixed growth	285	7.8

Frequency (n) represents the number of outcomes in each category

TABLE 3: Relationship Between Urine Culture Results and Patient Characteristics

	Frequency N (%)	No growth N (%)	P value	Mixed growth, N (%)	P value	Non-significant N (%)	P value	Significant growth, N (%)	P value
Sex			<.001		.248		<.001		<.001
Female	2189	1239 (56.6)		180 (8.2)		235 (10.7)		535 (24.4)	
Male	1463	978 (66.8)		105 (7.2)		87 (5.9)		293 (20.0)	
Age group (year)			<0.001		.567		<.028		<.001
<5	626 (17.1)	387 (61.8)		57 (9.1)		47 (7.5)		135 (21.6)	
5-17	507 (13.9)	350 (69.0)		38 (7.5)		38 (7.5)		81 (16.0)	
18-35	831 (22.8)	546 (65.7)		56 (6.7)		67 (8.1)		162 (19.5)	
36-60	980 (26.8)	568 (58.0)		79 (8.1)		111 (11.3)		222 (22.7)	
61 above	708 (19.4)	366 (51.7)		55 (7.8)		59 (8.3)		228 (32.2)	
Service Delivery Location			<0.001		.927		<.001		<.001
ICU	530 (14.5)	278 (52.5)		41 (7.7)		20 (3.8)		191 (36.0)	
Inpatient	1819 (49.8)	1124 (61.8)		145 (7.9)		154 (8.5)		396 (21.8)	
Outpatient	1303 (35.7)	815 (62.5)		99 (7.6)		148 (11.4)		241 (18.5)	

DISCUSSION

This study analysed the yield of urine culture as a diagnostic tool for clinically suspected UTI cases and the distribution of urine culture results in relation to patient sex, age, and service location, revealing key patterns that influence clinical and diagnostic practices. The study revealed a relatively low yield of urine cultures, with a significant number of samples showing negative results due to low counts and mixed growth. These findings suggest that a substantial proportion of patients presenting with symptoms and signs of UTI may not have bacterial infections detectable by standard urine culture techniques. The high rate of no growth and non-significant results highlights the need for improved diagnostic screening before processing urine cultures to reduce unnecessary testing and optimise patient care. Healthcare providers should be aware of the outcomes of urine cultures and implement diagnostic stewardship practices to maximise resource utilisation in UTI management.

The prevalence of laboratory-confirmed UTI in our study was relatively low compared to a study in Bagamoyo, Tanzania, which found that 38.5% of symptomatic individuals had positive urine cultures.[18] Another study in India in 2012 also reported a high positivity rate of 60%,[19] and the one in Seoul, Korea, reported an even higher positivity rate of 74.8%.[20] The varying findings of prevalence across studies indicate that positive urine culture results differ across different geographic regions. The variations can be attributed to differences in population demographics, laboratory techniques, healthcare practices, and antibiotic usage. The observed disparity highlights the importance of localised studies in guiding appropriate clinical decision-making.

On the distribution of urine culture results in relation to patient characteristics, this study revealed notable variations in urine culture results based on gender. The significant bacterial growth was more common in females, aligning with the well-known higher prevalence of urinary tract infections (UTIs) among women, which can be due to anatomical and physiological factors, such as a shorter urethra and closer proximity to the anal area.[2,21] Several other studies have also reported higher urine culture positivity rates in women than those observed in men.[20,22–24] The notably higher rates of non-significant growth in females may indicate contamination during sample collection, especially in outpatient settings where supervision is limited. Conversely, the higher rate of "no growth" among males may imply a lower occurrence of infection compared to females as their difference was statistically significant.

Age was also strongly associated with the results of urine cultures. Patients aged 61 years and above had the highest rate of significant growth, aligning with previous research that highlights older adults as being at increased risk for UTIs.[25] The increased UTI risk among the elderly can be due to comorbidities, catheter use, or weakened immunity. Our findings correlate with the study, which showed that *E. coli* was less prevalent in the youngest subjects and more frequent in the age groups above 15.[22] Furthermore, studies show that most positive cases are in the age group above 20.[24] Interestingly, children under five also showed a relatively high proportion of significant growth, underlining the importance of early detection in pediatric care as UTI at this age rarely shows classic UTI symptoms and the infection poses a risk of a permanent renal injury.[26] In contrast, adolescents had the lowest yield of significant growth, possibly due to lower biological risk or over-testing in symptomatic but non-infectious conditions.

The study examined urine culture outcomes across healthcare settings, including the ICU, inpatient wards, and outpatient clinics. Patients in the ICU and inpatients had significantly higher UTIs than outpatients. The findings suggest a greater burden of healthcare-associated infections, particularly catheter-associated urinary tract infections, as the procedure for inpatients and ICU patients can introduce pathogens into the urinary tract.[27] The lower proportion of "no growth" in this group supports the assumption that testing in critical care is typically more targeted.[28] Catheter-associated bacteriuria is one of the most common healthcare-associated infections worldwide, resulting from the widespread and often inappropriate use of urinary catheterisation in hospitals and long-term care facilities.[29] This variation is likely due to the increased prevalence of healthcare-associated infections, which are more common among hospitalised patients.[28] These findings underscore the crucial need for effective infection prevention strategies in healthcare facilities to mitigate the risks of UTIs among hospitalised patients.

The findings in this study highlight the importance of diagnostic stewardship, particularly in outpatient and non-critical care settings, in reducing unnecessary urine cultures and preventing inappropriate antibiotic use. The findings also highlight potential areas for improving sample collection practices, particularly among females and pediatric patients, to reduce nonsignificant and mixed growth rates. Tailored interventions, such as sample collection training for clinicians, age and sex specific diagnostic algorithms, and targeted testing criteria, may help optimize the diagnostic value of urine cultures.

Despite its valuable findings, this study has some limitations. The use of secondary data presented challenges, including missing clinical variables, transcription errors, and non-representative participant selection. Data inconsistencies and variations in sample quality may have impacted the accuracy of the results, but also the missing clinical data might have made it difficult to explain the possible causes of the non-significant results, which sometimes could be a result of previous use of antibiotics which was not captured in this study.[30] However, the study benefited from a large sample size, strengthening its statistical reliability. Future studies should incorporate prospective data collection to ensure comprehensive analysis and minimise biases.

CONCLUSION

This study demonstrates the low yield of urine cultures from among the clinically suspected UTI cases for the diagnosis of UTIs, as the majority of the cases were not confirmed microbiologically. It also describes significant differences in culture positivity across sex, age, and healthcare settings, underscoring the need for tailored laboratory and clinical practices. By refining diagnostic algorithms and sample handling processes, healthcare

providers can enhance the diagnostic yield of urine cultures and improve antimicrobial stewardship.

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