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Relationship Between Pyuria and Bacteriuria in Suspected Cases of Urinary Tract Infection

Shristi Raut,[1,2] Nitesh Raj Thapa,[1] Junu Richhingbung Rai, [1,2] Hari Prasad Kattel,[2] Sangita Sharma[1,2]

[1]Department of Microbiology, Maharajgunj Medical Campus, Kathmandu, Nepal, [2]Department of Microbiology, Tribhuvan University and Teaching Hospital, Kathmandu, Nepal.

ABSTRACT

Background: Urinary tract infection is one of the most common infections encountered worldwide and is a major public health problem. Urinary tract infection is diagnosed based on clinical features, pyuria and bacteriuria. The aim of this study was to determine the relationship between pyuria and bacteriuria in patients with suspected cases of urinary tract infection at Tribhuvan University and Teaching Hospital, Kathmandu.

Methods: A cross-sectional descriptive study was carried out from September to December 2023 in the Department of Microbiology at Tribhuvan University and Teaching Hospital. One thousand urine specimens were collected by the convenience sampling method from patients with suspected urinary tract infection and processed for routine macroscopic and microscopic examination followed by culture. The organisms were identified by standard microbiological methods as described by American society for Microbiology. Chi-square test was used wherever applicable with a p value<0.05 regarded as statistically significant.

Results: Out of 1000 urine specimens examined, pyuria was seen in 331(33.1 %) specimens. Among the 331 urine samples with pyuria, 137 (41.3 %) urine samples showed significant bacterial growth. Out of 669 urine specimens without pyuria, 33 (4.9%) showed significant bacterial growth. *Escherichia coli* was the most common organism causing urinary tract infection both with pyuria (71/98, 72.4%) and without pyuria (27/98, 27.6%). Culture positivity increased with the rising number of pus cells in the urine. This correlation between pus cell counts and culture positivity is statistically significant ($p < 0.001$).

Conclusions: Pyuria and significant bacteriuria may not always correlate in suspected cases of urinary tract infection. However, as the number of pus cell increases in microscopic examination of urine per high power field, the likelihood of getting urine culture positive result also increases.

Keywords: Bacteriuria; culture; pyuria; urinary tract infection.

INTRODUCTION

Urinary tract infections (UTIs) result from microbial invasion of the urinary tract, affecting the lower urinary tract (urethra and bladder) via ascending spread and the upper urinary tract (kidney and ureter) via both ascending and descending routes. About 10% of people experience a UTI during their lifetime. Anatomical factors in females and prostatic enlargement in elderly males contribute to an increased risk. Recurrence is high, with 50% of infections reoccurring within one year.[1,2]

Symptomatic UTIs account for approximately 7 million outpatient visits, 1 million emergency visits, and 100,000 hospital admissions annually.[3] They constitute 35% of nosocomial infections.[4] Catheter-associated UTIs cause nearly 1 million cases per year and are associated with higher morbidity and mortality. Laboratory diagnosis relies on the presence of pyuria and significant bacteriuria ($\geq 10^5$ CFU/mL). Pyuria is defined as ≥8000 pus cells/μL or ≥2 cells/high-power field (HPF). [5]

UTIs are common worldwide and prompt and accurate diagnosis is essential to prevent complications. Pyuria and bacteriuria are two key indicators for detecting UTIs. Pyuria can occur in non-infectious conditions, and bacteriuria can occur in the absence of pyuria.

Correspondence: Dr Shristi Raut, Department of Microbiology, Tribhuvan University and Teaching Hospital, Kathmandu, Nepal. Email: rautshristi@gmail.com, Phone: +9779841808394

Understanding the relationship between pyuria and bacteriuria helps clinicians decide when to request a urine culture, initiate empirical antibiotics and interpret pyuria and bacteriuria in different clinical contexts.

Inconsistent associations between pyuria and bacteriuria have been shown by various studies. Correlating pyuria with bacteriuria improves diagnostic accuracy, reduces misdiagnosis and helps minimizing unnecessary antibiotic use and antimicrobial resistance. In addition, the clinical significance of isolated pyuria and isolated bacteriuria needs to be explored in detail.

This study aims to determine the relationship between pyuria and bacteriuria in urine from patients with suspected urinary tract infection cases considering different levels of pyuria and the varieties of organisms isolated in urine.

METHODS

This cross-sectional descriptive study was carried out in the Department of Microbiology at Tribhuvan University and Teaching Hospital (TUTH), Kathmandu from September to December 2023. Informed consent was obtained from each patient prior to specimen collection and ethical approval was received from Institutional Review Board of the Institute of Medicine (Ref. number: 74 (6-11) E2).

All urine specimens from patients of all age groups presenting with clinical symptoms of UTI (burning micturition, urgency, increased frequency and dysuria) were included in this study. Specimens that were not labelled properly and received in a broken container were excluded. Specimens showing growth of multiple organisms or fungus were also excluded.

A total of 1,000 urine specimens were processed during the study period using the convenience sampling method. Macroscopic examination of the urine was performed, followed by detection of pyuria by microscopic examination. More than 5 pus cells/HPF were considered indicative of pyuria.[6] Bacteriuria was determined by culturing the specimens on cysteine lactose electrolyte-deficient (CLED) agar.

All the results were entered in the worksheet of SPSS and statistical analysis was performed. The chi-square test was applied wherever applicable, with a p value < 0.05 considered statistically significant.

RESULTS

Out of 1,000 urine specimens examined, pyuria was observed in 331 (33.1%). Among these, 137 (41.3%) showed significant bacterial growth. Of the remaining 669 urine specimens without pyuria, however, 4.9% (33/669) yielded significant bacterial growth. Most urine specimens were collected from outpatients (91.4%). Male and female patients accounted for 39.9% and 60.1 % of the cases respectively. The specimens were obtained from 1 month baby to 92 years old patients, with the highest number of specimens were from 21-30 years age group.

Based on visual inspection, 61.4 % of the urine samples appeared light yellow (normal), 26.6 % were turbid, 10.1 % were deep yellow and 1.9 % were reddish in appearance.

On microscopic examination of wet mounts prepared from centrifuged urine specimens, pus cells (leukocytes) were identified and quantified under high power field (HPF) to assess pyuria in the specimen. A total of 516 urine specimens had no pus cells/HPF, 239 had ≤ 10 pus cells/HPF and 245 had >10 pus cells/HPF. Subsequently when these urine specimens were cultured on CLED agar, significant bacteriuria (>10^5cfu/ml) was observed in 170 (17%) specimens, while low count significant growth (>10^3cfu/ml) was observed in 34 (3.4%) of urine specimens.

An increase in pus cell count per high power field was associated with a higher rate of culture positivity. Significant bacteriuria was observed in 15.6 % of female and 19.0 % of male urine samples, with no statistically significant difference between genders.

Among the 669 urine specimens that did not exhibit pyuria, 33 (4.9 %) and 15 (2.2 %) samples still demonstrated significant bacteriuria and low count significant bacteriuria upon culture respectively. Statistical analysis revealed a strong and significant correlation between pyuria and bacteriuria with a p-value <0.001 (**Table 1**). This finding indicates that an increased number of pus cells in urine is closely associated with a higher likelihood of significant bacteriuria.

Table 1. Distribution of Pyuria versus Bacterial count.

No. of pus cells/HPF	Total no. of samples (1000)	Bacterial count				p-value
		Significant growth (170)	Low count Significant (34)	Mixed growth (57)	No growth (739)	
0	516(51.6%)	14(2.7%)	11(2.1%)	7(1.3%)	484(93.7%)	<0.001
1-4	153(15.3%)	19(12.4%)	4(2.6%)	13(8.4%)	117(76.4%)	
5-10	86(8.6%)	20(23.2%)	4(4.6%)	11(12.7%)	51(59.3%)	
11-15	72(7.2%)	24(33.3%)	4(5.5%)	6(8.3%)	38(52.7%)	
16-20	30(3.0%)	17(56.6%)	0(0.0%)	8(26.6%)	5(16.6%)	
Plenty	84(8.4%)	39(46.4%)	7(8.3%)	7(8.3%)	31(36.0%)	
Packed	59(5.9%)	37(62.7%)	4(6.7%)	5(8.4%)	13(22.0%)	

Among the 204 urine specimens that were culture-positive, *Escherichia coli* (98/204, 48.0 %) was the most common organism, followed by *Klebsiella* spp. (31/204, 15.2 %). Notably, 25 (12.3%) organisms were recovered from urine specimens that showed no pus cells/HPF. Among these, *Escherichia coli* (16/25, 64 %) was the most frequently isolated organism followed by *Enterococcus* spp. (9/25, 31.0 %). The distribution of bacterial species isolated from culture-positive urine specimens in relation to pyuria and bacteriuria is presented in Table 2.

Table 2. Organism wise distribution of Pyuria and Bacteriuria.

Organism	Packed pus cells/HPF (41)	Plenty of pus cells/ HPF (46)	16-20 pus cells/ HPF (17)	11-15 pus cells/ HPF (28)	5-10 pus cells/ HPF (24)	1-4 pus cells/HPF (23)	No pus cell (25)	Total (204)
Escherichia coli	15 (15.3)	19 (19.4)	10 (10.2)	14 (14.3)	13 (13.3)	11(11.2)	16 (16.3)	98
***Klebsiella* spp.**	6 (19.4)	11 (11.2)	2 (6.5)	3(9.7)	2(6.5)	5 (16.1)	2(6.5)	31
Enterococcus species	7(24.1)	6 (20.7)	2(6.9)	3(10.3)	2(6.9)	5 (17.2)	4(13.8)	29
Pseudomonas aeruginosa	5(31.3)	4(25.0)		3(18.8)	2 (12.5)	1(6.3)	1(6.3)	16
Citrobacter freundii	1(10.0)	3 (30.0)	1(10.0)	1(10.0)	3(30.0)		1(10.0)	10
Coagulase *Staphylococci* (CONS)	4 (40.0)	1(10.0)	1(10.0)	1(10.0)	2(20.0)		1(10.0)	10
***Acinetobacter* spp.**	2 (50.0)	1(25.0)		1(25.0)				4
Staphylococcus aureus	1(33.3)		1(33.3)	1(33.3)				3
***Proteus* spp.**		1(33.3)		1(33.3)		1(33.3)		3

This section highlights the significance of the type of microorganism in relation to pyuria and bacteriuria including both significant and low count significant growth in urine culture.

DISCUSSION

Total 1000 urine specimens were processed for macroscopic and microscopic examination, followed by bacterial culture. The relationship between pyuria and bacteriuria were analysed. Pyuria is defined as the presence of ≥5

pus cells/HPF which corresponds to ≤ 25 leukocytes per ml of non-centrifuged urine.[6] Based on this definition, pyuria was detected in 331(33.1%) of the 1,000 urine specimens. Significant bacteriuria may sometimes occur in absence of symptoms and pyuria in patients who subsequently become symptomatic, for example, during pregnancy. In this study, 4.6% of patients showed significant bacteriuria without pyuria. Pyuria alone has inadequate diagnostic accuracy for predicting bacteriuria. As the number of pus cell per high power field increased, the likelihood of getting culture positive result also increased. Similar results have been reported in different studies in India.[7,8,9]

Only 137 (41.3 %) urine specimens showed significant bacteriuria in the presence of pyuria. Different studies conducted at various sites within Nepal have reported a wide range of percentage (33.7%-84.09%) of significant bacteriuria with pyuria. A small proportion of urine specimens (3.4%, 34/1000) showed low count significant bacteriuria (>10^4-<10^5cfu/ml) in this study. In certain conditions, such as in symptomatic females, catheterized patients, patients on antibiotics, and male patients, low count bacteriuria is considered clinically significant. Lower colony count (>10^2 cfu/ml) may still indicate a clinically significant UTI, particularly in *Enterococci* spp.[10]

The male to female patients' ratio of suspected UTI cases was 1:2 (399: 601). Female genital anatomy, sexual intercourse and pregnancy may contribute to the higher prevalence of UTIs in females. Most specimens were collected from the outpatient department. Significant bacteriuria was higher in inpatients (26.7%) than in outpatients (16.0%) which may be attributed to iatrogenic infections resulting from the use of catheters, probes and swabs in the hospital. Other complications, such as obstruction to flow of urine by tumours, strictures, stones or prostatic hypertrophy are also frequently associated with UTI in hospitalized cases.

The highest number of specimens were obtained from the age group 21-30 years whereas the maximum number of significant bacterial growth was observed in the 31-40 years age group, the majority of whom were female. Sexual activity accounts for 75-90 % of bladder infections.[11] In females of reproductive age group, high progesterone levels during pregnancy increase the risk of decreased muscle tone of the uterus and bladder, which can lead to a greater likelihood of reflux, allowing urine to flow back towards the kidneys.[12,13] Similar results were seen in other studies.[14,15,16] Statistical significant correlation was observed between turbidity and culture positivity in this study. Most of the significant bacterial growth was obtained in urine specimen with turbid appearance. Unusual turbidity in infected urine sample is likely caused by the presence of leukocytes, pathogens, or both. However, visual appearance is not a highly specific indicator for diagnosing urinary tract infection since amorphous phosphates can also cause normal, uninfected urine to appear turbid.[17]

Regarding the pattern of bacterial isolates, this study showed *E. coli* and *Klebsiella* spp. as the most common causes of urinary tract infection.[18] This finding is supported by an epidemiological study conducted in 2019 where *E. coli* was isolated in 46-66 % of cases and *Klebsiella* spp. was isolated in 3-16 % of cases.[19] In a similar study done by Shakya et al. in 2017 among UTI cases with significant bacteriuria, 80.9 % were *E. coli* and 4.5 % were *Klebsiella* spp.[20]

Moreover, 12.3 % of organisms were recovered from urine specimens without pus cells/HPF. Among these, *E. coli* was the most common organism, followed by *Enterococcus* spp. This result is consistent with a study conducted in Kathmandu in 2014.[21] Urinary tract infections caused by common organisms may occur with or without pyuria; however, bacteriuria with pyuria is significantly more prevalent.

The diagnosis of UTI is not always straightforward and must be distinguished from other conditions that have similar clinical presentations. Some UTIs can also be asymptomatic. This study revealed a significant correlation between pyuria and bacteriuria. However, a small percentage of urine specimens showed pyuria without bacteriuria and vice versa. Therefore, pyuria and bacteriuria may not always correlate in suspected cases of UTI. Nevertheless, as the number of pus cells in urine increases, the likelihood of a culture-positive result also rises. Asymptomatic bacteriuria in pregnant women requires treatment to prevent complications.[22] Significant pyuria with a sterile bacterial culture may occur in patients with prior antibiotic use, renal tuberculosis, corticosteroid therapy, analgesic nephropathy, renal calculi or in the presence of bacteria that are unable to grow on the routine culture media used in the laboratory.[23]

This study has several limitations. It was conducted at a single center, which may limit the generalization of the findings to other settings. Additionally, the study was carried out over a relatively short period, restricting the ability to observe longer-term trends. Furthermore,

patient outcomes following diagnosis and treatment were not tracked, which limits the assessment of the clinical impact of the findings.

CONCLUSIONS

Pyuria and bacteriuria may not always correlate in suspected cases of UTI; however, as the number of pus cells per high power field increases, the likelihood of a culture positive result also rises. Microscopic examination prior to culture is important for correlating pyuria and bacteriuria. Low-count bacteriuria should be considered clinically significant in symptomatic patients with pyuria. Pyuria with a sterile culture should prompt testing for other slow-growing organisms or fastidious organisms.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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