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*Original Article*

# Pyuria as a Clinically Relevant Urinary Marker Associated with Clinical Suspicion of Neonatal Urinary Tract Infection in Suprapubic Aspiration Samples: A Retrospective Study from Tobruk, Libya

**Amany Ibrahim Hassan[1*], Asma Abdulaziz Ibrahim[1], Nour Mosa Allafi[2], Marwa Mousa Mohammed[2], Raghda Abdalnaser Younis[2], Souad Faraj Sherfad[2], Fatima Saleh Mohammed[2], Ehdaa Mohammed Hamed[2]**

[1]Pediatric Department, Tobruk Medical Centre

[2]Medical College, University of Tobruk

Corresponding author, Amany Ibrahim Hassan.Email: amany.beedala@tu.edu.ly

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## Abstract

**Background:** Urinary tract infection (UTI) is a significant cause of neonatal morbidity worldwide, yet diagnosis remains challenging due to nonspecific clinical manifestations. Pyuria has long been considered a valuable indicator of UTI, but its diagnostic utility in neonates, particularly using uncontaminated specimens obtained by suprapubic aspiration (SPA), requires further investigation. **Objective:** This study aimed to evaluate the clinical significance and clinical utility of pyuria as the primary urinary marker for suspected neonatal UTI using SPA specimens. **Methods:** A retrospective observational study was conducted at Tobruk Medical Center, Libya, including 119 neonates (≤28 days) who underwent SPA urine collection between January 2024 and December 2025. Pyuria was defined as >5 white blood cells per high-power field (WBC/HPF). Clinical and laboratory data were extracted from medical records. Associations between pyuria, bacteriuria, SPA UTI-compatible composite findings, and clinician-recorded suspicion of UTI were evaluated using Pearson Chi-square and Fisher's exact tests. **Results:** Pyuria was identified in 46 of 119 neonates (38.7%; 95% CI: 30.4%–47.6%), representing the most frequently detected urinary abnormality, compared with bacteriuria (33.8%) and SPA UTI-compatible findings (20.3%). Mild pyuria (>5–10 WBC/HPF) was the predominant pattern (22.7%), followed by moderate (>10–20 WBC/HPF; 9.2%) and marked (>20 WBC/HPF; 6.7%). A strong and statistically significant association was observed between pyuria and clinician-recorded suspicion of UTI: all neonates with documented UTI (5/5, 100%) had pyuria, compared with 29 of 85 (34.1%) without documented UTI (Fisher's exact test, P = 0.006). In contrast, neither bacteriuria (P = 1.000) nor the SPA UTI-compatible composite (P = 0.518) demonstrated significant associations with clinician suspicion. Neonatal sepsis was the most common clinical diagnosis (43.5%), suggesting SPA was frequently performed as part of broader infection evaluations. No significant association was found between pyuria and antibiotic treatment regimen (P = 0.812). **Conclusion:** Pyuria is the most clinically relevant urinary marker for suspected neonatal UTI in SPA specimens, demonstrating a strong association with clinician-recorded diagnostic suspicion. These findings support the integration of pyuria assessment into routine diagnostic algorithms for neonatal UTI. However, the presence of pyuria in neonates without documented UTI and its absence in some suspected cases underscore the need for comprehensive clinical evaluation, including urine culture, to guide management decisions. Further prospective studies are warranted to validate optimal pyuria thresholds and investigate pathogen-specific patterns in this vulnerable population.

**Keywords:** Pyuria; Neonatal urinary tract infection; Suprapubic aspiration; Urinary markers; Bacteriuria; Neonatal sepsis; Clinical relevance; Libya; SPA UTI-compatible; White blood cells; Urinalysis; Neonate

## Introduction

Urinary tract infection (UTI) is among the most common serious bacterial infections affecting neonates and represents an important cause of neonatal morbidity worldwide. Early diagnosis is challenging because clinical manifestations are often nonspecific, including fever, poor feeding, lethargy, irritability, vomiting, apnea, jaundice, and failure to thrive. Delayed recognition may lead to bacteremia, renal parenchymal injury, renal scarring, hypertension, and chronic kidney disease, underscoring the importance of accurate and timely diagnosis. (1)

Obtaining an uncontaminated urine specimen is fundamental for the diagnosis of neonatal UTI. Several methods exist for urine collection in non-toilet-trained children, including bag collection, clean-catch, urethral catheterization, and suprapubic aspiration (SPA); among these, SPA carries the lowest likelihood of contamination and, despite being more invasive, has a high success rate and low complication rate. This makes SPA specimens the preferred reference standard in neonatal UTI research, enabling more reliable microbiological confirmation of true infection. (2)

Urinalysis is the initial laboratory investigation for suspected neonatal UTI and includes evaluation of pyuria, leukocyte esterase, nitrite, bacteriuria, and microscopic findings. Among these markers, pyuria, defined as the presence of white blood cells in the urine, reflects the host inflammatory response to bacterial invasion and has long been considered one of the most

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valuable indicators of urinary tract infection (3). However, interpretation of pyuria in neonates remains an area of active debate: its detectability appears to vary with the causative uropathogens, and a meaningful proportion of culture-confirmed infections can present without pyuria, meaning the marker should be interpreted as strongly supportive rather than infallible (4).

Pyuria is defined as the presence of an abnormally elevated number of white blood cells (leukocytes) in the urine, typically indicating an inflammatory response within the urinary tract to bacterial invasion. (5,6) In neonatal and pediatric practice, a threshold of more than 5 white blood cells per high-power field (WBC/HPF) on microscopic urinalysis is the most widely accepted criterion for clinically significant pyuria, as it balances diagnostic sensitivity and specificity in this age group.(3) Similarly, bacteriuria refers to the presence of bacteria in the urine; however, its interpretation is highly dependent on the method of collection. In the context of suprapubic aspiration—the gold standard for sterile collection—any detectable bacteriuria on microscopy or culture is considered significant, whereas in catheterized or bag specimens, a higher quantitative threshold is required to distinguish true infection from contamination. (2,4) Understanding these definitions is crucial for interpreting the clinical utility of each marker in neonatal populations.

Therefore, this study aims to evaluate the clinical significance and diagnostic performance of pyuria as the primary urinary marker for suspected neonatal urinary tract infection using suprapubic aspiration specimens. By examining the relationship between pyuria and clinician recorded suspicion of UTI , this research seeks to clarify the usefulness of pyuria in supporting early diagnosis and guiding clinical management of neonatal UTIs.

## Materials and Methods

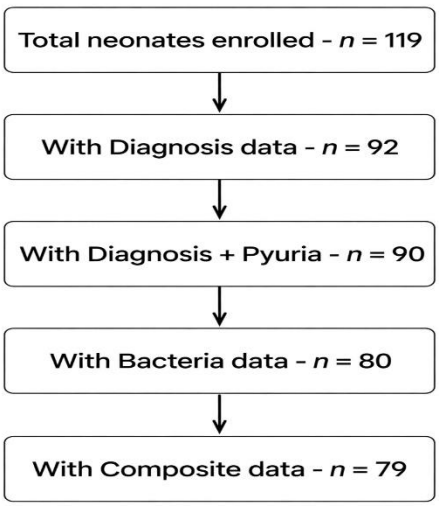
### Study Design and Setting

This retrospective observational study was conducted at Tobruk Medical Center, Tobruk, Libya, and included neonates evaluated between January 2024 and December 2025. The study aimed to evaluate the clinical relevance of pyuria as a urinary marker for suspected neonatal urinary tract infection (UTI) using suprapubic aspiration (SPA) urine specimens collected by clinician . Clinical and laboratory data were retrospectively collected from hospital medical records of neonates who underwent SPA urine sampling as part of the diagnostic work-up for suspected infection. Demographic characteristics, including age and sex, together with clinical diagnoses, laboratory findings, urine microscopy results and treatment information, were extracted from the medical records. The primary objective was to determine whether pyuria was more strongly associated with clinicians' suspicion of UTI than other urinary markers, including bacteriuria and the SPA UTI-compatible composite findings.

### Study Population

A total of 119 neonates who underwent suprapubic aspiration urine collection were included in the study. Eligible patients were identified through laboratory records, and all available clinical and microscopic urine examination data were reviewed. Analyses involving individual variables were performed using complete-case analysis; therefore, the number of observations varied according to data availability.

**Figure 1. Flowchart of study sample**




Neonates (≤28 days of age) , aspiration for urine collection ,

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Available microscopic urinalysis, Available clinical diagnosis or differential diagnosis.

**Exclusion Criteria :** Missing microscopic urine examination, Missing clinical documentation relevant to study outcomes . **Urine Collection and Laboratory Examination**

Urine samples collected by physician were obtained by suprapubic aspiration under sterile conditions according to institutional clinical protocols. Microscopic urinalysis was performed immediately after collection. Pyuria was defined as more than 5 white blood cells (WBCs) per high-power field (HPF). For descriptive analysis, pus-cell severity was classified into four categories: 0–5 cells/HPF , >5–10 cells/HPF, >10–20 cells/HPF, >20 cells/HPF. Additional urine findings included bacteriuria and an SPA UTI-compatible composite variable.

**Clinical Variables**

Clinician suspicion of urinary tract infection was determined from the recorded diagnosis or differential diagnosis documented in the medical records. Cases were categorized as: UTI/rule-out UTI and No documented UTI Other diagnosis categories included neonatal sepsis, neonatal jaundice, pneumonia/respiratory disorders, cyanosis, and miscellaneous neonatal conditions. Treatment regimens administered during hospitalization were also recorded.

**Outcome Measures**

The primary outcome was the association between pyuria and clinician-recorded suspicion of neonatal urinary tract infection. Secondary outcomes included: prevalence of pyuria, severity distribution of pyuria, comparison of pyuria with bacteriuria and SPA-compatible urine findings, association between pyuria and diagnosis categories, association between pyuria and treatment regimen.

**Ethical Considerations**

Ethical approval was obtained from the Research Ethics Committee of Tobruk University (Approval No. NBC:009.H.26.35

**Statistical Analysis**

Data were analyzed using IBM SPSS Statistics (Version 27). Categorical variables were summarized as frequencies and percentages. The prevalence of major urinary findings was presented together with 95% confidence intervals (95% CI). Associations between categorical variables were evaluated using the Pearson Chi-square test. Fisher's exact test was used whenever expected cell frequencies were less than five. A two-sided P-value <0.05 was considered statistically significant. Cases with missing data were excluded from individual analyses; therefore, the valid sample size differed between variables.

## Results:

A total of 119 neonates who underwent suprapubic aspiration (SPA) urine sampling during evaluation for suspected infection were included in the study. The mean age was 11.3 ± 8.0 days**,** with a median age of 9 days**.** Male neonates accounted for 76 (63.9%) of the study population, whereas 43 (36.1%) were female (Table 1).

**Table 1.** Demographic characteristics of the study population (n = 119)

| Variable | Value |
|---|---|
| **Age (days), mean ± SD** | 11.3 ± 8.0 |
| Median age (days) | 9.0 |
| **Sex** | |
| Male | 76 (63.9%) |
| Female | 43 (36.1%) |

Among the urinary markers evaluated, pyuria (>5 WBC/HPF) demonstrated the highest diagnostic yield. Pyuria was identified in 46 of 119 neonates (38.7%; 95% CI: 30.4%–47.6%). Bacteriuria was detected in 27 of 80 evaluable urine samples (33.8%; 95% CI: 24.3%–44.6%), while the SPA UTI-compatible composite finding was present in 16 of 79 neonates (20.3%; 95% CI: 12.9%–30.4%). The relatively wider confidence interval observed for the SPA-compatible composite reflected the smaller number of positive cases. Overall, pyuria represented the most frequently identified urinary abnormality among neonates investigated for suspected UTI (Table 2, Figure 1).

**Table 2.** Diagnostic Yield of Pyuria and Other Urinary Markers in Neonates Evaluated for Suspected Urinary Tract Infection.

| Finding | Valid N | N positive | % | 95% CI |
|---|---|---|---|---|
| Pyuria positive (>5 WBC/HPF) | 119 | 46 | 38.7% | 30.4%-47.6% |
| Bacteria positive | 80 | 27 | 33.8% | 24.3%-44.6% |
| SPA UTI-compatible composite | 79 | 16 | 20.3% | 12.9%-30.4% |

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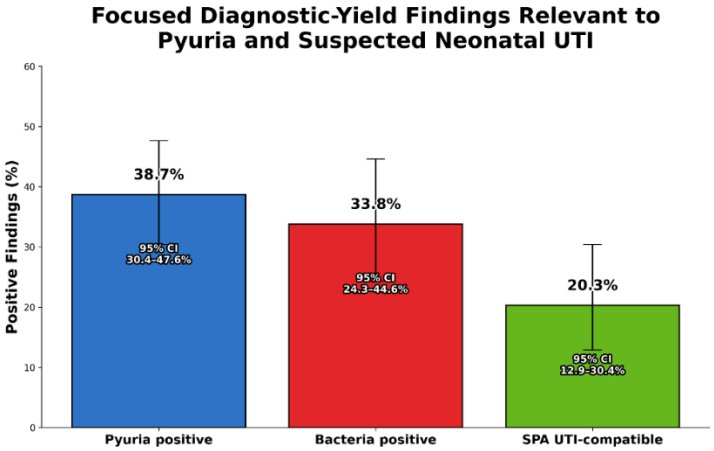



**Figure 1: Diagnostic of Urinary Markers Among Neonates with Suspected Urinary Tract Infection**

Microscopic examination of SPA urine specimens showed that 73 of 119 neonates (61.3%) had normal urinary leukocyte counts (0–5 WBC/HPF). Pyuria (>5 WBC/HPF) was observed in 46 neonates (38.7%). Mild pyuria (>5–10 WBC/HPF) was the predominant pattern, affecting 27 neonates (22.7%), followed by moderate pyuria (>10–20 WBC/HPF) in 11 (9.2%) and marked pyuria (>20 WBC/HPF) in 8 (6.7%). These findings indicate that mild pyuria constituted the largest proportion of pyuria-positive cases in the study population (Table 3, Figure 2).

**Table 3.** Distribution of Pyuria Severity in Suprapubic Aspiration Urine Specimens.

| Variable | Category | Valid N | n | % |
|---|---|---|---|---|
| Pus cell severity | 0-5 cells/HPF | 119 | 73 | 61.3% |
| Pus cell severity | >5-10 cells/HPF | 119 | 27 | 22.7% |
| Pus cell severity | >10-20 cells/HPF | 119 | 11 | 9.2% |
| Pus cell severity | >20 cells/HPF | 119 | 8 | 6.7% |
| Pyuria summary | >5 cells/HPF total | 119 | 46 | 38.7% |

***Note:*** *Pyuria was defined as >5 WBC/pus cells per high-power field.*

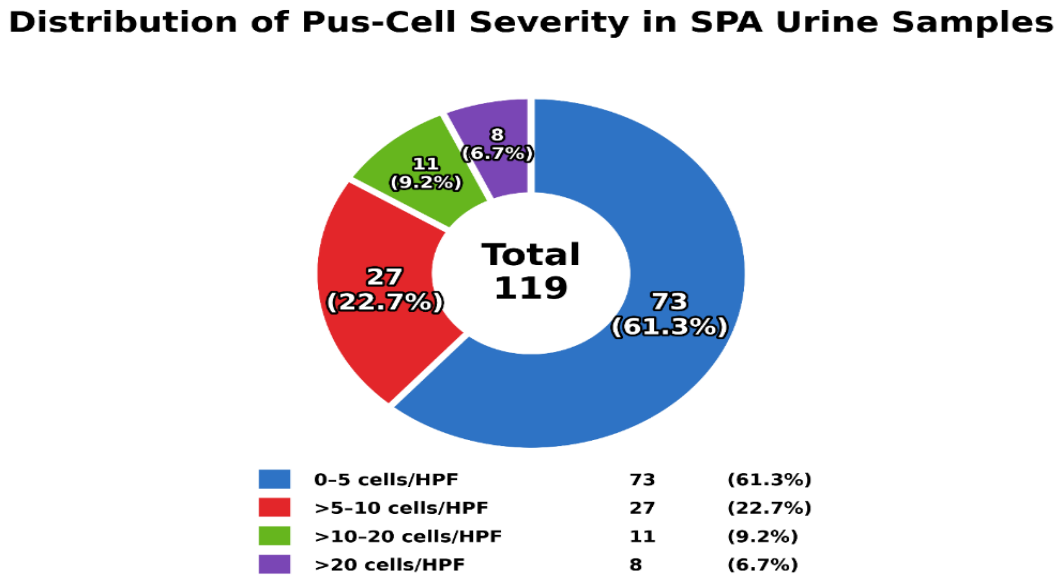



**Figure 2: Distribution of Pyuria Severity in Suprapubic Aspiration Urine Samples**

Clinical documentation revealed that UTI was infrequently recorded as either a diagnosis or differential diagnosis. Among the 92 neonates with available clinical records, only 5 (5.4%) had documented UTI or rule-out UTI, whereas 87 (94.6%) had no recorded suspicion of UTI. Neonatal sepsis was the most common clinical

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diagnosis, accounting for 40 cases (43.5%), suggesting that SPA urine sampling was frequently performed as part of a broader evaluation for neonatal infection rather than specifically for suspected urinary tract infection (Table 4, Figure 3).

**Table 4.** Clinical Characteristics of Neonates According to Documented Suspicion of Urinary Tract Infection.

| Clinical variable | Category | Valid N | n | % |
|---|---|---|---|---|
| UTI mentioned in diagnosis/DD | No UTI mentioned | 92 | 87 | 94.6% |
| UTI mentioned in diagnosis/DD | UTI mentioned | 92 | 5 | 5.4% |
| Diagnosis/DD category | UTI / rule-out UTI | 92 | 5 | 5.4% |
| Diagnosis/DD category | Neonatal sepsis | 92 | 40 | 43.5% |

**Note:** The diagnosis/DD field was used as the available indicator of clinicians considering or suspecting UTI.

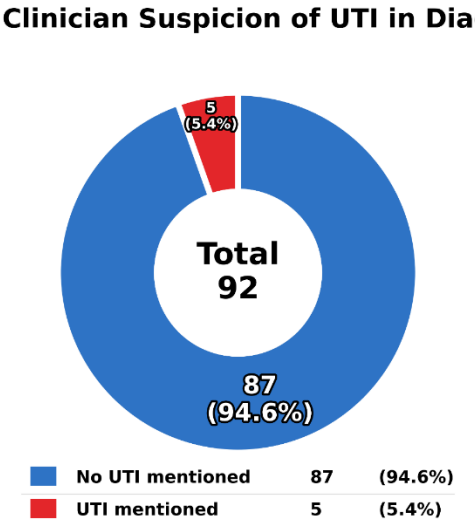



**Figure 3:** Distribution of Clinician-Recorded Diagnoses Among Neonates Undergoing Suprapubic Aspiration.

Pyuria demonstrated the strongest association with clinician-recorded suspicion of UTI. All neonates with documented UTI (5/5, 100%) had pyuria, compared with 29 of 85 neonates (34.1%) without documented UTI. This association was statistically significant (Fisher's exact test, P = 0.006). In contrast, neither bacteriuria nor the SPA UTI-compatible composite was significantly associated with clinician suspicion of UTI. Bacteriuria was present in 33.3% of neonates with documented UTI and 38.0% of those without documented UTI (P = 1.000), whereas the SPA-compatible composite was identified in 33.3% and 20.4%, respectively (P = 0.518) (Table 5, Figure 4).

**Table 5**. Association Between Pyuria and Other Urinary Markers with Clinician Suspicion of Neonatal Urinary Tract Infection**.**

| SPA/urine marker | Clinical variable | Valid N | Positive rate by clinical category | Test | p-value |
|---|---|---|---|---|---|
| Pyuria positive | UTI mentioned in DD | 90 | No UTI mentioned: 29/85 (34.1%); UTI mentioned: 5/5 (100.0%) | Fisher's exact | 0.006 |
| SPA UTI-compatible composite | UTI mentioned in DD | 52 | No UTI mentioned: 10/49 (20.4%); UTI mentioned: 1/3 (33.3%) | Fisher's exact | 0.518 |
| Bacteria positive | UTI mentioned in DD | 53 | No UTI mentioned: 19/50 (38.0%); UTI mentioned: 1/3 (33.3%) | Fisher's exact | 1.000 |

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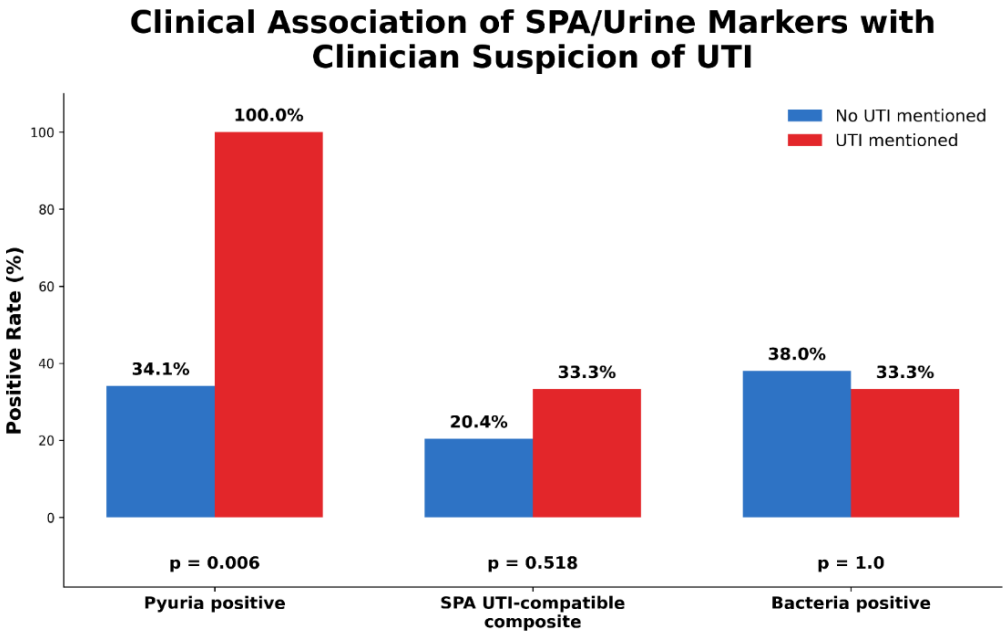



**Figure 4:** Association Between Pyuria and Clinician Suspicion of Neonatal Urinary Tract Infection.

Further analysis demonstrated that pyuria remained significantly associated with clinician-recorded suspicion of UTI (P = 0.006). The prevalence of pyuria was highest among neonates with documented UTI or rule-out UTI (100%), followed by neonatal sepsis (40.0%), pneumonia/respiratory disorders (37.5%), neonatal jaundice (31.8%), miscellaneous diagnoses (22.2%), and cyanosis (16.7%). Although differences across diagnosis categories approached statistical significance, the overall association did not reach the predefined threshold for significance Fisher's exact test, P = 0.065 No statistically significant association was observed between pyuria and antibiotic treatment regimen ( Fisher's exact test, P = 0.812). was detected in 41.1% of neonates receiving ampicillin, cefotaxim, and gentamicin combination therapy, 35.7% of those receiving ampicillin and cefotaxim, 42.9% of those treated with amoxicillin-based regimens, and 25.0% of neonates receiving other antimicrobial or supportive treatments. These findings suggest that pyuria was more strongly associated with clinicians' diagnostic suspicion of UTI than with antibiotic prescribing patterns (Table 6, Figure 5).

**Table 6.** Clinical Correlates of Pyuria in Neonates Undergoing Suprapubic Aspiration.

| Pyuria clinical variable | Valid N | Positive rate by clinical category | Test | p-value |
|---|---|---|---|---|
| UTI mentioned in DD | 90 | No UTI mentioned: 29/85 (34.1%); UTI mentioned: 5/5 (100.0%) | Fisher's exact | 0.006 |
| Diagnosis/DD category | 90 | Neonatal sepsis: 16/40 (40.0%); Neonatal jaundice: 7/22 (31.8%); UTI / rule-out UTI: 5/5 (100.0%); Pneumonia/respiratory: 3/8 (37.5%); Cyanosis: 1/6 (16.7%); Other diagnosis: 2/9 (22.2%) | Fisher's exact | 0.065 |
| Treatment regimen | 119 | No treatment recorded: 0/1 (0.0%); Ampicillin + Cefotaxim + Gentamicin: 37/90 (41.1%); Ampicillin + Cefotaxim: 5/14 (35.7%); Amoxicillin regimen: 3/7 (42.9%); Amikacin/Meropenem: 0/3 (0.0%); Other antibiotic/supportive: 1/4 (25.0%) | Fisher's exact | 0.812 |

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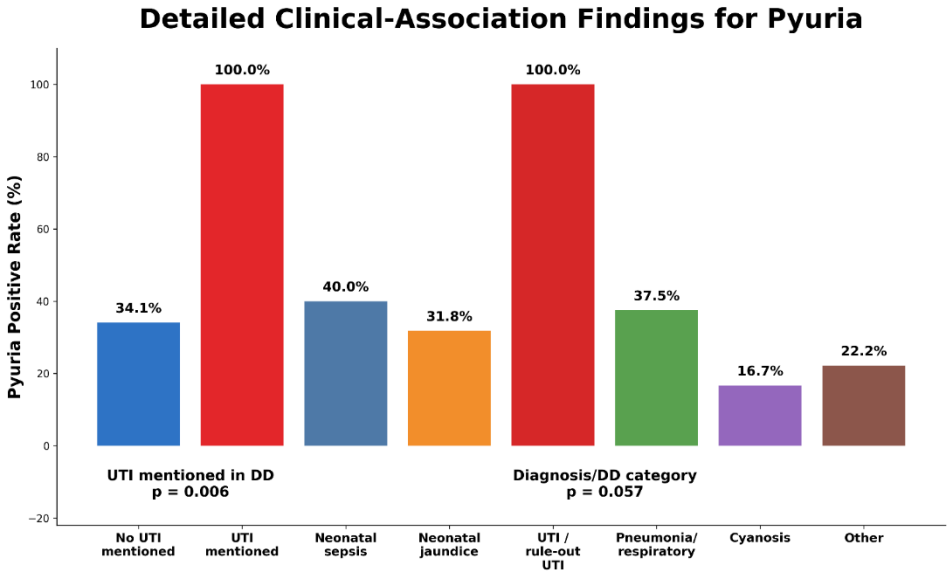



**Figure 5: Clinical Distribution of Pyuria According to Diagnosis Category and Treatment Regimen**.

## Discussion

This study evaluated the clinical significance of pyuria as a urinary marker for suspected neonatal urinary tract infection (UTI) using suprapubic aspiration (SPA) specimens. Our findings demonstrate that pyuria is the most clinically relevant urinary marker, showing a statistically significant association with clinician-recorded suspicion of UTI, whereas bacteriuria and the SPA UTI-compatible composite finding were not significantly associated. Pyuria (>5 WBC/HPF) was the most frequently identified urinary abnormality, present in 38.7% of neonates evaluated for suspected infection, exceeding bacteriuria (33.8%) and the SPA UTI-compatible composite (20.3%). The predominance of mild pyuria (>5–10 WBC/HPF, 22.7% of cases) compared with moderate (9.2%) and marked pyuria (6.7%) suggests that even low-grade pyuria may be clinically meaningful in this population.

The strong association between pyuria and clinician-recorded suspicion of UTI (100% of neonates with documented UTI had pyuria, versus 34.1% without documented UTI; P = 0.006) reinforces pyuria's diagnostic utility. A 2025 systematic review of pyuria's diagnostic accuracy in pediatric UTI similarly concluded that pyuria remains one of the most consistently useful urinary markers (5). A 2024 US multicenter study comparing several methods of assessing pyuria against culture-confirmed UTI found that a meaningful minority of children with positive cultures still lacked pyuria, reinforcing that pyuria should be treated as a strong, but not infallible, supportive marker rather than a standalone diagnostic criterion (6); an accompanying editorial argued for reexamining, rather than discarding, pyuria's role in UTI diagnosis given its continued correlation with true infection (3).

Broader pediatric evidence indicates that the degree and detectability of pyuria can vary by causative organism, which may explain some 'pyuria-negative' UTI cases seen clinically (4), a pattern echoed in an Asian pediatric cohort in which non-E. coli pathogens, younger age, and shorter fever duration before presentation were independently associated with pyuria-negative UTI (7). A large observational study from Spain evaluating 367 febrile infants with pyuria found positive urine cultures in the large majority of cases, predominantly due to E. coli, while also showing that Gram stain performed less well for identifying non-E. coli infections — supporting the principle that pyuria and adjunct urine tests each have pathogen-dependent blind spots (8). Meta-analytic evidence assessing rapid urine tests in children has likewise shown that combining dipstick markers (leukocyte esterase and nitrite) improves specificity relative to either test alone, while microscopic pyuria contributes meaningfully to overall diagnostic accuracy — an argument for multi-marker interpretation rather than reliance on any single urinary finding (9).

Regional data support similar conclusions in resource-limited settings. An Egyptian NICU-based study found pyuria significantly associated with culture-proven UTI, with neonates showing pyuria roughly five times more likely to have UTI, alongside high specificity but modest sensitivity for this marker alone (10). Guidelines endorsed by the Saudi Pediatric Infectious Diseases Society similarly recognize SPA as a reliable neonatal collection method and support urinalysis, including pyuria, as an integral part of the initial diagnostic evaluation (11). Within the regional literature on neonatal jaundice and UTI, pathological renal ultrasonography — rather than pyuria alone — has also been shown to independently associate with UTI, suggesting that imaging can complement urinalysis when the clinical picture is ambiguous (12).

The predominance of neonatal sepsis as the leading clinical diagnosis in our cohort (43.5%) suggests SPA

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was frequently performed within broader sepsis evaluations rather than for isolated UTI suspicion, consistent with the nonspecific presentation of neonatal infection generally. The lack of association between pyuria and antibiotic regimen (P 0.812) likely reflects that empirical broad-spectrum therapy in neonatal sepsis is driven by overall clinical suspicion rather than isolated urinary findings, in line with guidance emphasizing that a properly collected specimen — by catheterization or SPA — combined with clinical–laboratory judgment, rather than any single marker, should guide the diagnosis and management of infant UTI (13).

Taken together, these results support incorporating pyuria into the routine evaluation of suspected neonatal UTI, particularly where SPA specimens are available. However, its presence in over a third of neonates without documented UTI, and its absence in a subset of suspected cases, confirms that pyuria cannot substitute for urine culture and comprehensive clinical assessment. Larger prospective, multicenter studies are needed to validate optimal pyuria thresholds and characterize pathogen-specific pyuria patterns in neonates.

**Limitations**

This study has some important limitations. First and foremost, the absence of urine culture data precludes definitive diagnosis of UTI and assessment of pyuria's diagnostic accuracy. Second, the retrospective design relies on documentation quality and may introduce information bias. Third, clinical diagnosis \DD data were available for only 90 of the 119 neonates , the remaining 29 cases had missing DD information and were therefore excluded from analysis involving DD and the sample size varied across analyses because some data were missing in the medical records**.** Fourth , clinician suspicion was used as the standard, which is subjective and may have been influenced by knowledge of pyuria results . Fifth., the small number of neonates with documented UTI (n=5) limits statistical power. Sixth, the SPA UTI-compatible composite was not explicitly defined in clinical protocols. Seventh , the study was conducted at a single center, limiting generalizability.

**Conclusions**

This study demonstrates that pyuria is the most clinically relevant urinary marker for suspected neonatal UTI in SPA specimens, showing a strong association with clinician-recorded diagnostic suspicion. Our findings support the incorporation of pyuria assessment into routine diagnostic algorithms for neonatal UTI, particularly when SPA is used for urine collection. However, the presence of pyuria in a substantial proportion of neonates without documented UTI, and its absence in some cases of suspected infection, underscores the need for comprehensive clinical evaluation including urine culture. Future research should focus on prospective validation of pyuria thresholds in SPA specimens, investigation of pathogen-specific patterns of pyuria, and assessment of pyuria's predictive value for long-term outcomes such as renal scarring.

**Recommendations**

Based on the findings of this study, pyuria should be routinely assessed as part of the initial evaluation of neonates with suspected urinary tract infection, particularly when suprapubic aspiration specimens are available. However, pyuria should always be interpreted alongside urine culture findings and the overall clinical presentation rather than being used as a standalone diagnostic marker. Future multicenter prospective studies with larger sample sizes are recommended to validate optimal pyuria thresholds, evaluate pathogen-specific inflammatory responses, and improve the diagnostic accuracy of neonatal urinary tract infection in different clinical settings.

**Conflict of Interest**

The authors declare that they have no conflict of interest

**Funding status**

No funds for this manuscript

**Interest conflict**

The authors declare that there is no conflict of interest

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