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Silent Signals in Urine: A Cross Sectional Study on Urinalysis Abnormalities and Antibiotic Resistance in Women

Running Title: Silent Signals in Urine

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A B S T R A C T

Introduction: Urinary tract infections (UTIs) remain a major cause of morbidity among women globally, particularly in low and middle-income countries. Urinalysis provides rapid detection of abnormalities suggestive of infection while culture and susceptibility testing guide effective therapy. This study evaluated urinalysis abnormalities, bacterial isolates and antibiotic susceptibility patterns among women presenting with urinary symptoms.

Methods: A cross-sectional study of 100 female participants presenting with urinary symptoms was conducted. Midstream urine samples were subjected to physical, chemical and microscopic examination, followed by culture and antimicrobial susceptibility testing using the Kirby-Bauer disc diffusion method in accordance with CLSI 2023 guidelines.

Results: Proteinuria (45%), pyuria (38%) and haematuria (18%) were the most common abnormalities. Microscopy revealed epithelial cells (79%) and pus cells (38%). A total of 22 bacterial isolates were recovered, with Klebsiella pneumoniae (37%) and Escherichia coli (25%) predominating. Aminoglycosides showed the highest sensitivity (81.3%), while β-lactams exhibited high resistance (56.3%). Chi-square analysis demonstrated a significant association between antibiotic class and susceptibility outcome ($\chi^2 = 30.6$, $p = 0.001$).

Conclusion: Urinalysis abnormalities are important indicators of urinary tract pathology. Culture-based diagnosis remains essential for guiding appropriate therapy. High resistance to β-lactams highlights the need for antimicrobial stewardship in primary healthcare settings.

Keywords: Urinalysis, Urinary tract infection, Antibiotic resistance, Women, Antimicrobial stewardship

1. Introduction

Urinary tract infections (UTIs) are among the most common bacterial infections affecting women worldwide[1,2]. Symptoms of these infections often present as subtle abnormalities that serve as signals of underlying disease and contribute significantly to morbidity among patients, particularly from low and middleincome countries where diagnostic facilities are limited and empirical treatment is common[3,4].

Women are particularly vulnerable to UTIs due to positioning of their anatomy including shorter urethra and proximity to the perineal region, which facilitate bacterial colonization[5-8]. Poor management or treatment of recurrent infections can lead to complications including chronic kidney disease and infertility[8].

Urinalysis offers a rapid and costeffective means of detecting signs of urine infection such as proteinuria, pyuria, hematuria and other abnormalities, that may otherwise go unnoticed[9,10]. When combined with culture and antibiotic susceptibility testing, urinalysis provides a comprehensive picture of infection burden that could guide evidencebased therapy[11-13]. Previous studies across Nigeria and other regions have consistently identified Escherichia coli and Klebsiella pneumoniae as predominant uropathogens, with rising resistance to commonly prescribed antibiotics[14,15].

This study was designed to evaluate findings from both urinalysis and antibiotic susceptibility patterns among women presenting with urinary symptoms. By identifying the signals in urine and mapping the trends in resistance patterns, the research aims to strengthen diagnostic accuracy, inform empirical treatment choices and highlight the urgent need for antimicrobial stewardship in women's health

2. Methods

2.1. Study design and population

This cross-sectional study recruited 100 female participants aged 6 years and above presenting with symptoms suggestive of urinary tract infection from Township Primary Health Care (PHC), Jos, Nigeria. Due to the commercial hub of Jos, Township PHC is one of the busiest primary healthcare facilities in the metropolis, recording one of the highest patient attendance rates per year among PHC centres in the area. It serves as a major healthcare access point for women from both urban and semi-urban communities within Jos and its surrounding areas.

2.2. Inclusion and exclusion criteria

Women aged 18 years and above who presented with symptoms suggestive of urinary tract infection and provided informed consent to participate in the study were included. Women who had used antibiotics within the two weeks preceding sample collection, as well as those with a known history of chronic renal disease, were excluded from participation.

2.3. Sample collection and analysis

Midstream urine samples were collected from participants using sterile containers. The samples were transported immediately to the laboratory for analysis. Urinalysis including physical, chemical and microscopic examinations were performed on the samples. The physical examination involved assessment of urine colour and turbidity. Chemical analysis was carried out using standard urine dipstick test strips to determine parameters such as pH, protein, glucose, ketones, nitrite, leukocyte esterase, blood and urobilinogen according to the manufacturer's instructions. Microscopic examination of the urine sediment was conducted after centrifugation to detect the presence of pus cells (leukocytes), red blood cells, epithelial cells and microorganisms.

For bacteriological analysis, urine samples were incubated for 24 hours in media broth and then subculture on MacConkey agar and Blood agar at 37 °C for 18-24 hours. Following incubation, bacterial growth was examined and isolates were identified based on colony morphology, Gram staining characteristics and standard biochemical tests including catalase, coagulase, indole, citrate utilization, urease and oxidase tests, where applicable.

Antimicrobial susceptibility testing of the isolates was performed using the Kirby-Bauer disc diffusion method on Mueller-Hinton agar. Antibiotic discs representing commonly used classes such as fluoroquinolones, β-lactams, aminoglycosides and macrolide, were applied to the inoculated plates. The plates were incubated at 37 °C for 18-24 hours, after which the zones of inhibition were measured and interpreted as sensitive, intermediate or resistant according to the guidelines of the Clinical and Laboratory Standards Institute (CLSI).

2.4. Data analysis

Data were analysed using SPSS version 27. Descriptive statistics were expressed as frequencies and percentages. Associations were tested using Chi-square, with $p< 0.05$ considered significant. Confidence interval (95% CI) was calculated where applicable.

3. Results

Table 1: Age Distribution of Female Participants Included in the Study (n = 100).

Age Group (years)	Frequency (n)	Percentage (%)
6–18	7	7
19–25	11	11
26–40	57	57
>40	25	25

The age distribution revealed that participants within the age of 26-40 years (57%) were the majority of the population, closely followed by participants aged above 40 years (25.0%). Participants aged, 19-25 years accounted for 11.0% of the population while participants aged 6-18 years (7%) formed the least population **(Table 1)**.

Table 2: Distribution of Urinalysis parameters among study participants (n=100).

Characteristic	Parameter	Positive (%)	Negative (%)
Chemical Properties	Protein (Proteinuria)	45	55
	Blood (Hematuria)	18	82
	Others (Nitrites, Ketones, Glucose)	16	84
	pH (7.0–7.5)	100	0
Microscopy	Pus Cells (Leukocytes)	38	62
	Epithelial Cells	79	21
	Others (Casts, Yeast Cells, RBCs)	21	69

Urinalysis revealed notable abnormalities across both chemical and microscopic parameters. Among the chemical properties analysed, proteinuria was the most prevalent finding, observed in 45.0% of participants, followed by hematuria (18.0%) and other abnormalities including nitrites, ketones and glucose (16.0%). Urine pH within the range of 7.0–7.5 was observed in all samples (100%) **(Table 2)**.

Microscopic examination showed a high presence of epithelial cells in 79.0% of samples, while pus cells were detected in 38.0% of participants, indicating inflammatory processes consistent with infection. Other microscopic findings, including casts, yeast cells and red blood cells, were present in 21.0% of samples **(Figure 1)**.

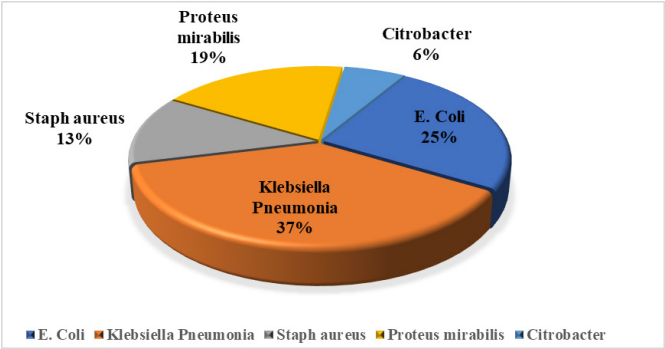

Figure 1: Distribution of uropathogens isolated from urine samples (n = 22).

A total of 22 bacterial isolates were identified, with Gram-negative organisms accounting for the majority of cases. Klebsiella pneumoniae was the most frequently isolated pathogen (37%), followed by Escherichia coli (25%) and Proteus mirabilis (19%). Gram-positive Staphylococcus aureus accounted for 13% of isolates, while Citrobacter species were least represented (6%).

Table 3: Antibiotic Susceptibility Patterns by Antibiotic Class Among Bacterial Isolates (n = 22).

Antibiotic Class	Sensitive (%)	Resistant (%)	Intermediate (%)	X2 (df)	P-value
Fluoroquinolones	68.8	17.5	13.7		
β-lactams	35.4	56.3	8.3		
Aminoglycosides	81.3	0	18.7	30.6 (6)	0.001
Macrolides	75	0	25		

Antibiotic susceptibility patterns varied significantly across the different antibiotic classes (χ^2 = 30.6, p = 0.001). Aminoglycosides demonstrated the highest sensitivity (81.3%) with no observed resistance, followed by macrolides (75.0%), which also showed no resistance. Fluoroquinolones exhibited moderate sensitivity (68.8%) with some degree of resistance (17.5%) and intermediate response (13.7%). In contrast, β-lactam antibiotics showed the lowest sensitivity (35.4%) and the highest resistance rate (56.3%), indicating reduced effectiveness against the bacterial isolates in this study.

4. Discussion

The urinalysis findings in this study highlight the signs of infection that often precede obvious clinical symptoms. Proteinuria (45%), pyuria (38%) and hematuria (18%) were the most frequent abnormalities, underscoring the burden of urinary tract morbidity among women. These signals, though subtle, provide critical clues to underlying pathology. The predominance of alkaline urine further supports conditions favorable to bacterial growth, particularly ureasplitting organisms such as Proteus mirabilis. Recognizing these silent signals is essential for timely diagnosis and intervention.

Proteinuria and hematuria, consistent with urinary tract inflammation, align with previous reports from Nigerian and subSaharan African populations[16-18]. Pyuria, detected in over onethird of participants, strongly suggests infection and correlates with bacterial culture results. The high prevalence of epithelial cells (79%) likely reflects contamination during sample collection, emphasizing the need for improved patient education. These findings demonstrate that urinalysis, when interpreted carefully, remains a valuable screening tool for women's health[19].

Culture confirmed the presence of uropathogens, with Klebsiella pneumoniae (37%) and Escherichia coli (25%) as the leading isolates. This distribution mirrors global and regional trends, where Gramnegative organisms dominate UTI etiology[20-22]. The identification of Staphylococcus aureus, Proteus mirabilis and Citrobacter species, though less frequent, highlights the diversity of pathogens capable of exploiting urinary tract vulnerabilities[23,24].

The susceptibility profile revealed concerning resistance trends. βlactams exhibited the highest resistance (56.3%), reflecting widespread misuse and overprescription in community settings[25,26]. In contrast, aminoglycosides (Gentamicin, 81.3% sensitivity) and macrolides (Azithromycin, 75% sensitivity) retained strong efficacy, positioning them as viable empirical options. Fluoroquinolones demonstrated variable activity, with some agents showing complete sensitivity while others exhibited moderate resistance. These findings reinforce global concerns about rising resistance and the urgent need for stewardship[27,28].

The integration of urinalysis and culture provides a dual lens: urinalysis reveals signals of infection, while culture confirms pathogen identity and resistance. Together, they form a powerful diagnostic framework for guiding therapy [29,30]. For women, particularly in resourcelimited settings, this approach can reduce misdiagnosis, improve treatment outcomes and slow the spread of resistance. Strengthening laboratory capacity, ensuring proper urine collection and embedding antimicrobial stewardship into routine care are critical steps toward safeguarding women's health[31,32].

5. Conclusion

This study highlights the silent signals in urine; proteinuria, pyuria and hematuria, as common markers of infection among women. Klebsiella pneumoniae and Escherichia coli were the leading pathogens, reflecting global UTI trends. Antibiotic susceptibility testing revealed strong activity of aminoglycosides and macrolides, but alarming resistance to βlactams. Recognizing these abnormalities through routine urinalysis, combined with culturebased therapy, is vital for guiding treatment and curbing resistance. Strengthening laboratory capacity, improving patient education on urine collection and implementing antimicrobial stewardship programs are critical steps toward safeguarding women's health and preserving antibiotic effectiveness.

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