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The value of interleukin-1 beta (IL-1β) measurement in the detection of bacterial urinary tract infection in symptomatic and asymptomatic bacteriuria patients

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Abstract

Urinary tract infections (UTIs) are common bacterial infections that trigger inflammatory responses, while asymptomatic bacteriuria involves bacterial presence without symptoms. Diagnosing UTIs can be challenging and delays may lead to complications or antibiotic misuse. Interleukin-1 beta (IL-1β), an early proinflammatory cytokine detected in urine, shows potential as a rapid UTIs diagnostic biomarker. This study aimed to investigate urinary IL-1β levels in patients with symptomatic UTIs, asymptomatic bacteriuria, and normal control individuals. We compared IL-1β levels between subjects with multidrug-resistant (MDR), and others with drug-sensitive bacterial infections. This study included 150 subjects who were categorized into three groups: symptomatic UTIs, asymptomatic bacteriuria, and normal controls. Urine samples were collected aseptically and analyzed using Cystine Lactose Electrolyte Deficient (CLED) agar culture and antimicrobial susceptibility testing (disc diffusion method). Urinary IL-1β levels were measured using ELISA. *Escherichia coli* was the most commonly isolated organism, followed by *Klebsiella pneumoniae*. Cefotaxime, amikacin, and cefixime showed good sensitivity, with cefixime being significantly more effective in asymptomatic bacteriuria. IL-1β levels were markedly higher in symptomatic UTI patients, followed by asymptomatic bacteriuria, and lowest in the controls. The highest IL-1β levels were associated with *E. coli* infections and MDR strains. In conclusion, urinary IL-1β represents a promising biomarker for UTI diagnosis, capable of distinguishing between UTI cases and normal controls and correlating with bacterial resistance patterns. These findings support the incorporation of IL-1β measurement into clinical practice to enhance diagnostic accuracy and improve infection management strategies.

Keywords: Iterleukin-1 beta (IL-1β); Asymptomatic bacteriuria; Urinary tract infections (UTIs); biomarker.

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Introduction

Urinary tract infections (UTIs) are one of the most prevalent bacterial illnesses that cause varying degrees of inflammatory reactions.[1] When a significant number of bacteria are found in a urine sample without any indications of a urinary tract infection, this is known as asymptomatic bacteriuria (ASB).[2] Advanced age, diabetes, impaired cognitive function, structural abnormalities of the urinary tract, and indwelling catheters are risk factors for ASB.[3] In general, a positive urine culture, together with a combination of relevant signs and symptoms, is required to confirm the diagnosis.[4]

Co-morbid patients and the elderly may have unusual UTI symptoms. People with cognitive impairment have trouble diagnosing lower urinary tract symptoms, but those with prostatic enlargement, non-infectious urethritis, bladder dysfunction, bladder tumors, and distal ureteric stones may have them without UTIs.[5]

Urine cultures take 1–3 days to produce results. In this case, diagnosis and antibiotic treatment would be delayed. Misuse of antibiotics increases resistance. A delayed treatment could affect patient conditions. Thus, UTI biomarkers that simplify clinical diagnosis are needed.[5]

In the context of infections, cytokines are key regulators of the local inflammatory response. Uropathogenic *Escherichia coli* bacteria induce the production of proinflammatory cytokines. Interleukin-1 (IL-1) is the first cytokine observed in the immune response to antigen recognition. There are two primary types of IL-1: IL-1α and IL-1β.[6] IL-1β, a proinfammatory cytokine, is largely produced by macrophages and monocytes. It causes tissue damage as well as neutrophil infiltration.[7]

During the inflammatory process, IL-1β serves two purposes. It initiates the immune cascade during acute infections. However, elevated IL-1β levels during persistent infections result in tissue damage.[8] In the urinary system, this kind of tissue damage causes uroepithelial cells to exfoliate. Now that the bacteria can hide in deeper tissues, they can develop antibiotic resistance.[9]

In this study, IL-1β was explored over other urinary markers due to its early role in the immune response cascade. Urine IL-1β testing is clinically feasible and potentially useful for assessing systemic inflammation.[10]

Thus, the current study was conducted to investigate the levels of IL-1β in the urine of patients with symptomatic UTI as compared with asymptomatic ones, either with microbes detected or normal people, to support the clinical diagnosis of UTI. We compared the levels of IL-1β in multidrug-resistant (MDR) and drug-sensitive bacterial infections.

Subjects and Methods

This was a cross-sectional descriptive and analytical study, performed at the Medical Microbiology and Immunology Laboratories, Damietta Faculty of Medicine (girls), Al-Azhar University, Damietta, Egypt. The study was conducted over one-year duration.

This study involved 150 subjects chosen from 400 subjects admitted to outpatient clinics of the departments of Urological, Internal Medicine, Obstetrics and Gynecology at Al-Azhar University Hospital, Damietta Faculty of Medicine (girls). They were chosen based on clinical symptoms and urine culture results and categorized into three groups: symptomatic UTIs, asymptomatic bacteriuria, and normal controls. We chose pregnant women without vaginal discharge, diabetic patients and old men with senile prostatic hyperplasia.

Patients under treatment with antibiotic therapy, patients with chronic conditions such as renal failure, liver failure, or renal transplantation, patients under immunosuppressive medication and patients with indwelling catheters were excluded from the study.

Laboratory investigations

Midstream clean-catch urine samples were collected from all participants in sterile containers. The samples were transported immediately to the laboratory where they were subjected to: physical examination, microscopic and direct film examination.

Bacterial culture

The samples were cultured using a sterile calibrated disposable loop (0.01 ml) onto Cystine-Lactose-Electrolyte-Deficient (CLED) agar. The plates were incubated aerobically at 37°C for 24–48 hours. Bacterial colonies were counted and multiplied by 100 on plates. A significant count was ≥ 105 colony forming unit (CFU)/ml.

The organisms were identified by colony morphology, gram staining and biochemical reactions: triple sugar iron, citrate utilization test, sulfide indole motility and urease test for Gram -ve and catalase test and coagulase test for Gram +ve.[11]

Antibiotic sensitivity test was done by the Kirby-Bauer disc diffusion on Muller-Hinton agar and commercial antibiotic discs. Zones of growth inhibition around each disc were measured and interpreted according to the Clinical and Laboratory Standards Institute (CLSI) guidelines.[12]

Maintenance of urine samples

All urine samples were centrifuged at 400-1000 xg for 20 minutes; the supernatant was collected and then stored at -20°C.

Estimation of interleukin-1β level in the urine

This was done using Enzyme-Linked Immunosorbent Assay (ELISA) kits (Catalogue No: E0143Hu 96T, Shanghai Korain Biotech) according to the manufacturer's guide using a micro plate reader at 450 nm.

Statistical Analysis

The collected data were coded, processed and analyzed with the Statistical Package for Social Sciences (SPSS) version 26 for Windows® (IBM, SPSS Inc., Chicago, IL, USA). Qualitative data are showed as number (frequency) and percent. The Chi-Square test (Monte-Carlo test as a correction) was used for the comparison between groups. The Kolmogorov-Smirnov test was used to determine normality of quantitative data. Parametric data are showed as median ± standard deviation (SD), while non-parametric data expressed as median (range). To compare three groups with normally distributed quantitative variables, the one-way analysis of variance (ANOVA) test was used, and the Kruskal-Walli test used if the data were abnormally distributed. An independent samples t-test was used to compare two groups with parametric data. The differences were considered statistically significant when the *p* value was ≤ 0.05.

Results

According to the demographic data, the mean age was not significantly different, 51.60 ± 17.69, 49.22 ± 17.10, and 48.74 ± 12.85 years in the symptomatic UTI, asymptomatic bacteriuria, and control groups, respectively (p = 0.634). Regarding gender distribution, males constituted 50.0% in the symptomatic UTI and control groups and 44.0% in the asymptomatic bacteriuria group, while females made up 50.0%, 56.0%, and 50.0%, respectively, with no statistically significant difference (p=0.786) (Table1).

Table 1. Demographic data of the study groups.

Parameter		Symptomatic UTI (n=50)	Asymptomatic Bacteriuria (n=50)	Control (n=50)	*p* value
Age (years)	Mean ± SD	51.60 ± 17.69	49.22 ± 17.10	48.74 ± 12.85	^{F}NS
	Median (Min-Max)	57.00 (19.00-72.00)	52.50 (20.00-73.00)	50.00 (25.00-73.00)	
Gender	Male	25 (50.0%)	22 (44.0%)	25 (50.0%)	$^{X^2}$NS
	Female	25 (50.0%)	28 (56.0%)	25 (50.0%)	

UTI: Urinary tract infections; SD: Standard Deviation; X^2: Chi-Square Test Statistic; F: One-way ANOVA Test Statistic; $p > 0.05$ is not significant (NS).

Regarding the risk factors and bacterial culture results, diabetes was observed in 54.0% of the symptomatic UTI group and 62.0% of the asymptomatic bacteriuria group, with no statistically significant difference (p=0.442). Benign prostatic hyperplasia (BPH) was noted in 24.0% and 14.0%, while pregnancy was reported in 22.0% and 24.0% of the two study groups, respectively, with no statistically significant differences. *E. coli* was the predominant pathogen found in 34.0% of the symptomatic UTI group and 40.0% of the asymptomatic bacteriuria group, followed by *K. pneumoniae*, which was found in 30.0% and 32.0%, respectively, for other bacteria, including *Citrobacter* spp., *S. aureus*, coagulase-negative *staphylococci*, and *Proteus mirabilis*, showing no significant differences (p=0.437) (Table 2).

Table 2. Risk factors and urine bacterial culture in the bacteriuria groups.

Parameter	Category	Symptomatic UTI (n=50)	Asymptomatic Bacteriuria (n=50)	X^2 p value
Risk factors	Diabetes	27 (54.0%)	31 (62.0%)	NS
	BPH	12 (24.0%)	7 (14.0%)	
	Pregnancy	11 (22.0%)	12 (24.0%)	
Urine Bacterial Culture	*Citrobacter species*	4 (8.0%)	2 (4.0%)	NS
	Escherichia coli	17 (34.0%)	20 (40.0%)	
	Staphylococcus aureus	5 (10.0%)	2 (4.0%)	
	Coagulase negative staphylococci (CONS)	6 (12.0%)	3 (6.0%)	
	Proteus mirabilis	3 (6.0%)	7 (14.0%)	
	Klebsiella pneumoniae	15 (30.0%)	16 (32.0%)	

UTI: Urinary tract infections; BPH: benign prostatic hyperplasia, X^2: Chi-Square Test Statistic; $p > 0.05$ is not significant (NS).

According to antibiotic susceptibility, resistance to ciprofloxacin was observed in 24.0% of the symptomatic UTI group and 20.0% of the asymptomatic bacteriuria group (p=0.809). Resistance to nitrofurantoin was noted in 22.0% and 12.0%, respectively (p=0.287). Resistance to trimethoprim was found in 20.0% of the symptomatic UTI group and 18.0% of the asymptomatic bacteriuria group (p=1.000). Resistance to cefixime showed a significant difference, with 26.0% of the symptomatic UTI group being resistant compared to 6.0% in the asymptomatic bacteriuria group (p=0.014). Other antibiotics, including augmentin, ceftriaxone, and fosfomycin, did not show significant differences in resistance patterns (p>0.05) (Table 3).

According to IL-1β levels, the mean ± SD values were 825.43 ± 484.10 pg/ml for the symptomatic UTI group, 444.53 ± 177.93 pg/ml for the asymptomatic bacteriuria group, and 179.90 ± 35.94 pg/ml for the control group, showing a statistically significant difference (p<0.001) (Table 4).

Table 3. Resistance information and antibiotics susceptibility parameters in the bacteriuria groups.

Antibiotic		Symptomatic UTI (n=50)	Asymptomatic Bacteriuria (n=50)	X^2 *p* value
Resistance	MDR	15 (30.0%)	10 (20.0%)	NS
	MDS	35 (70.0%)	40 (80.0%)	
Ciprofloxacin	Sensitive	38 (76.0%)	40 (80.0%)	NS
	Resistant	12 (24.0%)	10 (20.0%)	
Nitrofurantoin	Sensitive	39 (78.0%)	44 (88.0%)	NS
	Resistant	11 (22.0%)	6 (12.0%)	
Trimethoprim	Sensitive	40 (80.0%)	41 (82.0%)	NS
	Resistant	10 (20.0%)	9 (18.0%)	
Augmentin	Sensitive	37 (74.0%)	43 (86.0%)	NS
	Resistant	13 (26.0%)	7 (14.0%)	
Ceftriaxone	Sensitive	37 (74.0%)	43 (86.0%)	NS
	Resistant	13 (26.0%)	7 (14.0%)	
Cephalexin	Sensitive	39 (78.0%)	43 (86.0%)	NS
	Resistant	11 (22.0%)	7 (14.0%)	
Fosfomycin	Sensitive	40 (80.0%)	43 (86.0%)	NS
	Resistant	10 (20.0%)	7 (14.0%)	
Cefuroxime	Sensitive	38 (76.0%)	42 (84.0%)	NS
	Resistant	12 (24.0%)	8 (16.0%)	
Amikacin	Sensitive	41 (82.0%)	43 (86.0%)	NS
	Resistant	9 (18.0%)	7 (14.0%)	
Gentamicin	Sensitive	40 (80.0%)	42 (84.0%)	NS
	Resistant	10 (20.0%)	8 (16.0%)	
Cefixime	Sensitive	37 (74.0%)	47 (94.0%)	0.014
	Resistant	13 (26.0%)	3 (6.0%)	
Cefotaxime	Sensitive	43 (86.0%)	46 (92.0%)	NS
	Resistant	7 (14.0%)	4 (8.0%)	
Piperacillin Tazobactam	Sensitive	39 (78.0%)	43 (86.0%)	NS
	Resistant	11 (22.0%)	7 (14.0%)	
Amoxicillin/Sulbactam	Sensitive	40 (80.0%)	43 (86.0%)	NS
	Resistant	10 (20.0%)	7 (14.0%)	
Imepenem	Sensitive	39 (78.0%)	44 (88.0%)	NS
	Resistant	11 (22.0%)	6 (12.0%)	
Meropenem	Sensitive	40 (80.0%)	44 (88.0%)	NS
	Resistant	10 (20.0%)	6 (12.0%)	
Cefazolin	Sensitive	41 (82.0%)	41 (82.0%)	NS
	Resistant	9 (18.0%)	9 (18.0%)	
Tobramycin	Sensitive	38 (76.0%)	42 (84.0%)	NS
	Resistant	12 (24.0%)	8 (16.0%)	

X^2: Chi-Square Test Statistic; $p > 0.05$ is not significant (NS).. MDR: Multidrug-Resistant; MDS: Multidrug-Sensitive.

Table 4. Interleukin 1B level among the symptomatic, asymptomatic and control groups.

Parameter	Symptomatic UTI (n=50)	Asymptomatic Bacteriuria (n=50)	Control (n=50)	H *p* value
IL-1β level (pg/ml) Mean ± SD	825.43 ± 484.10	444.53 ± 177.93	179.90 ± 35.94	<0.001

UTI: Urinary tract infections; SD: Standard Deviation; H: Kruskal-Wallis Test Statistic; $p \leq 0.05$ is significant.

IL-1β: Interleukin-1 Beta.

According to IL-1β levels by bacterial culture, the highest mean levels were observed in *E. coli* (1635.33 ± 1030.71 pg/ml), followed by *K. pneumoniae* (718.89 ± 217.74 pg/ml) and *S. aureus* (703.40 ± 196.33 pg/ml). Lower levels were found in *Citrobacter* species (637.66 ± 187.37 pg/ml), *P. mirabilis* (420.99 ± 138.36 pg/ml), and *CONS* (394.01 ± 115.93 pg/ml), with a significant difference among the groups (p<0.001) (Table 5).

According to IL-1β levels by resistance profile, the mean level in MDR cases was 811.36 ± 676.40 pg/ml, while in multidrug-sensitive (MDS) cases, it was 576.18 ± 250.52 pg/ml and this difference was statistically significant (p=0.016) (Table 6).

Table 5. Interleukin-1 Beta (IL-1 β) according to the bacterial cultures.

Parameter	IL-1β (pg/ml) Mean ± SD
***Escherichia coli* (n=37)**	1635.33 ± 1030.71
***Klebsiella pneumoniae* (n=31)**	718.89 ± 217.74
***Staphylococcus aureus* (n=7)**	703.40 ± 196.33
***Citrobacter* species (n=6)**	637.66 ± 187.37
***Proteus mirabilis* (n=10)**	420.99 ± 138.36
***CONS* (n=9)**	394.01 ± 115.93
***p* value**	^{H}p<0.001

SD: Standard Deviation; H: Kruskal-Wallis Test Statistic; *$p \leq 0.05$ is significant. IL-1β: Interleukin-1 Beta.

Table 6. Interleukin-1 Beta (IL-1 β) according to drug resistance.

Parameter	MDR (n=25)	MDS (n=75)	*p* value
IL-1β (pg/mL) Mean ± SD	811.36 ± 676.40	576.18 ± 250.52	^{Z}p=0.016

SD: Standard Deviation; Z: Mann-Whitney U Test Statistic; $p \leq 0.05$ is significant. IL-1β: Interleukin-1 Beta; MDR: Multidrug-Resistant; MDS: Multidrug-Sensitive.

Discussion

Our results showed that diabetes was the most common risk factor in both the symptomatic UTI and asymptomatic bacteriuria groups. Several studies support the link between diabetes and urinary infections. For instance, Labi et al., 2015, found a higher prevalence of ASB among pregnant women with diabetes, reinforcing the idea that hyperglycemia and immune alterations contribute to bacterial colonization in the urinary tract.[2] Similarly, research by Luu and Albarillo, 2022, emphasized diabetes as a significant risk factor for ASB, which, if left untreated, can progress to symptomatic UTIs.[3] This progression highlights the importance of proactive screening and intervention, particularly for individuals with poorly controlled diabetes. Given the potential for complications such as pyelonephritis and urosepsis, targeted strategies, including glycemic control and early antibiotic treatment in selected cases, may be beneficial. While other risk factors such as BPH and pregnancy were present in our study population, they did not show significant differences between groups. This aligns with findings by Petty et al., 2019, who noted that while BPH and pregnancy are recognized contributors to bacteriuria, their impact may vary depending on the demographic and clinical characteristics of the population studied.[4] The variability in risk factor influence underscores the complexity of urinary infections and suggests that patient-specific factors, such as immune status and comorbidities, play a crucial role in infection susceptibility.

E. coli was the most frequently isolated pathogen in both symptomatic UTI and ASB groups, followed by *K. pneumoniae*. This is consistent with the study by Yuan et al., 2022, which identified *E. coli* as the predominant pathogen in urinary infections. Other bacteria, including *Citrobacter* species, *S. aureus, coagulase-negative staphylococci*, and *P. mirabilis*, were also identified in our study but

did not show statistically significant differences between the study groups.[13] This distribution aligns with the broader epidemiological patterns observed in urinary tract infections.

Our findings indicated that MDR bacteria were more prevalent in symptomatic UTI patients compared to ASB, although the difference was not statistically significant. This observation is in line with the study by Maldonado-Barragán et al., 2024, which found that most of the isolates from patients with symptomatic UTIs were MDR.[14] Another study by Ramos-Castaneda et al., 2019, found a lower prevalence of MDR among ASB patients undergoing urological procedures.[15] These findings suggest that while MDR bacteria are present in both groups, symptomatic UTIs are associated with a higher resistance profile, requiring targeted antibiotic management and diagnostic approaches.

The observation that IL-1β levels were significantly higher in symptomatic UTI patients and asymptomatic bacteriuria compared to controls aligns with several previous studies. Al-Saowdy and Abbas, 2024, found that urine IL-1β level was significantly greater in the UTI group than in the controls.[16] Similarly, Oudah et al., 2024, showed a significant elevation of serum IL-1β level in patients with UTI compared to controls.[17]

The observation that the highest levels of IL-1β were seen in symptomatic UTI patients compared to other groups aligns with previous researches. For instance, Akhlaghpour et al., 2024, showed a significant elevation of urine IL-1β level in symptomatic cases with positive microbe identification compared to asymptomatic cases with or without microbe identification.[18] These findings are due to active inflammation and mucosal irritation, which stimulate higher IL-1β release.

The study noted that *E. coli*-infected cases had the highest IL-1β levels, followed by those infected with *K. pneumoniae* and *S. aureus*, while *Citrobacter* species, *P. mirabilis*, and coagulase-negative *staphylococci* were associated with lower IL-1β levels. This variation in IL-1β expression across bacterial species is consistent with findings by the study of Jung et al., 2019, who observed differential IL-1β induction by uropathogenic *E. coli* correlating with its phylotype.[7] Such differences may be attributed to the varying pathogenic mechanisms and immune evasion strategies employed by different bacteria.

The finding that MDR cases exhibited significantly higher IL-1β levels compared to MDS cases is corroborated by the study of Kannian et al., 2020, who reported elevated urinary IL-1β levels in infections caused by multidrug-resistant *E. coli* and *K.* species.[10] This suggests that MDR infections may provoke a more robust inflammatory response, potentially due to the increased virulence or persistence of these pathogens. These patients may need therapeutic immune modulation using IL-1β inhibitors to reduce the inflammatory process and tissue pathology, leading to better disease management.

Recent studies highlighted the growing role of urine biomarkers in the diagnosis of UTIs. The study by Akhlaghpour et al., 2024, and Edwards et al., 2023 reported that urine biomarkers offer a more reliable diagnostic tools compared to traditional urine cultures,[18, 19] in line with our findings. The superior accuracy of biomarkers may be attributed to their ability to detect infection-related molecular changes in real time, reducing false negatives and improving early diagnosis. This advancement is particularly valuable in clinical settings where timely and precise identification of UTIs is critical for effective management and treatment.

Also, the study by Sun et al., 2024, emphasized the diagnostic potential of molecular biomarkers in UTI detection.[20] Their findings align with our observations regarding the ability of biomarkers in identifying infections, suggesting that these tools may eventually replace or complement traditional urine cultures. Molecular biomarkers, such as inflammatory proteins and microbial DNA signatures, provide a more direct assessment of infection presence and severity. By leveraging these indicators, clinicians can improve diagnostic precision, minimize unnecessary antibiotic use, and tailor treatments to individual patients more effectively.

Despite the advantages of biomarkers, some researchers advocate for a multimodal approach

to UTI diagnosis. The study by Haley et al., 2023, argued that multiplex polymerase chain reaction (PCR) identified UTI cases that standard urine cultures failed to detect, highlighting the limitations of relying solely on conventional methods.[21] Their study suggested that incorporating multiple diagnostic techniques, including biomarkers and advanced molecular assays, could enhance detection rates and improve patient outcomes. Given these insights, future research should explore the integration of biomarkers with PCR-based methods to establish a comprehensive and efficient diagnostic framework for UTIs.

Regarding inflammatory markers in UTIs, our findings align with those of the study by Ebrahimzadeh et al., 2024, who demonstrated that inflammatory biomarkers significantly enhance the diagnosis of recurrent UTIs in postmenopausal women.[22] This suggested that inflammation-associated markers can serve as reliable indicators of infection persistence and recurrence, particularly in populations with higher susceptibility. Similarly, the study by Shaikh et al., 2023, identified specific biomarkers linked to febrile UTIs in children, highlighting the critical role of inflammatory markers in stratifying disease severity across different age groups.[23] These findings emphasized the growing importance of biomarker-based approaches in UTI diagnosis, allowing for more accurate risk assessment and timely intervention.

While inflammation-related biomarkers provide valuable diagnostic insights, certain markers may be more relevant to specific UTI subtypes. The study by Sheu et al., 2007, underscored the role of urine IL-1β in acute pyelonephritis and renal scarring, suggesting that some inflammatory markers may indicate more severe infections or long-term complications [8] This differentiation is crucial for tailoring treatment strategies, as patients with elevated IL-1β levels may require more aggressive management to prevent renal damage. These findings reinforce the need for a targeted approach to biomarker utilization, ensuring that the selection of inflammatory markers aligns with the clinical presentation and severity of the infection.

Studies by Ambite et al., 2021a, and Jafari & Rohn, 2023, investigated the molecular determinants of UTI severity and host-pathogen interactions. Their findings align with our study's observations on host immune responses, further supporting the notion that host-pathogen interactions influence UTI outcomes.[24, 25]

The study by Butler et al., 2023, highlighted the potential of phytotherapy (BNO 1045) as an alternative treatment for acute lower UTIs, demonstrating its ability to normalize local host immune responses.[26] This finding suggested that plant-based therapies could play a role in reducing inflammation and promoting recovery without the overuse of antibiotics, a factor particularly relevant given concerns about antibiotic resistance. While our study did not extensively explore phytotherapy, these findings support the value of using therapeutic immune modulation using IL-1β inhibitors, especially in MDR cases that had the highest IL-1β levels, to reduce the inflammation and tissue pathology, leading to better disease management.

The study by Haley et al., 2024, highlighted the prevalence of different uropathogens detected by multiplex polymerase chain reaction and their association with infection-related biomarkers, supporting our conclusions regarding the need for advanced detection techniques.[27] In the same line, the study by Yu et al., 2024, further reinforced the importance of urine biomarkers in distinguishing between lower urinary tract dysfunction and UTIs, underscoring the clinical relevance of biomarker-based diagnostics.[28]

Finally, findings of this study are in agreement with existing literature, reinforcing the potential of urinary IL-1β as a valuable biomarker for diagnosing UTIs and differentiating between various clinical conditions and bacterial profiles.

In conclusion, our study demonstrated that IL-1β levels were significantly elevated in symptomatic UTI patients and in asymptomatic bacteriuria compared to controls, highlighting its potential as a diagnostic biomarker for UTI diagnosis. IL-1β levels in MDR cases were significantly higher compared to MDS cases, indicating a possible association between

antibiotic resistance and higher inflammation levels, highlighting that IL-1β level may serve as a valuable biomarker for identifying patients with difficult MDR bacterial infections. *E. coli* was the most frequently isolated pathogen. Antibiotic resistance was more common in symptomatic UTI cases, with cefixime showing a significantly higher resistance rate. These findings support the incorporation of IL-1β measurement into clinical practice to enhance diagnostic accuracy and improve infection management strategies.

Author Contributions

MEES: Performed the laboratory work, collected the data, and served as the corresponding author. RAA: Provided supervision, validation, and microbiological analysis. SAE: Study design, statistical analysis, manuscript review and editing. AMAA: Clinical pathology support, interpretation of results. All authors contributed to the writing and revision of the manuscript.

Declaration of Conflicting Interests

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Ethical approval

The study protocol was reviewed and approved by the Ethics Committee, at the Faculty of Medicine (girls), Cairo, Al-Azhar University (approval number 2209 on 19/12/2023).

Informed consent

A signed consent form was obtained from each study participant.

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