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Evaluation Of C-Reactive Protein In Urinary Tract Infected Patients Attending Madonna University Teaching Hospital

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Abstract

This study was carried out to determine the level of C-reactive protein (CRP) in Urinary Tract infection Patients attending Madonna University Teaching Hospital. C-reactive protein was measured using the ELISA (Enzyme-Linked Immunosorbent Assay) method. The statistical software for social sciences (SPSS) version 26 was used to statistically analyze the data acquired from this study. C-reactive protein values in the UTI group (20.75±8.35 mg/L) were significantly higher than those in the control group (3.08±1.28 mg/L), demonstrating a strong inflammatory response to UTIs. Additionally, age-related study showed that children and adolescents had greater CRP levels than adults. Patients with Escherichia coli showed considerably higher CRP levels than Klebsiella pneumoniae and Proteus mirabilis in the bacterial growth categories, however no significant difference was seen between Klebsiella pneumoniae and Proteus mirabilis. Differences in immune response dynamics, pathogen pathogenicity, and host-pathogen interactions can be used to explain these variances in CRP levels. The results show how useful CRP is as an inflammatory marker in UTIs.

INTRODUCTION

The blood plasma contains an annular (ring-shaped) pentameric protein called C-reactive protein (CRP), the content of which increases in response to inflammation. It is an acute-phase protein with hepatic origin that rises when macrophages and T cells secrete interleukin-6. In order to activate the complement system via C1q, its physiological function is to bind to lysophosphatidylcholine expressed on the surface of dead or dying cells (and some other types of bacteria) (Pope & Choy, 2021; Nayak et al., 2012; Bajic et al., 2015; Litvack & Palaniyar, 2010).

In reaction to substances secreted by macrophages and fat cells (adipocytes), the liver produces CRP. It belongs to the family of proteins called pentraxins (Luo & Lin, 2021; Stanimirovic et al., 2022; Guerreiro et al., 2022). It has nothing to do with protein C (blood coagulation) or C-peptide (insulin). The first pattern recognition receptor (PRR) discovered was C-reactive protein (Sheriff et al., 2021; Li & Wu, 2021).

Acute phase reactants, such as CRP, are proteins produced by the liver and released into the blood within hours of tissue damage, the start of an infection, or another inflammatory trigger. Significantly elevated values are seen, for instance, following injury or a heart attack, when autoimmune illnesses are active or uncontrolled, and when people have serious bacterial infections like sepsis (Wimalawansa, 2023; Jarczak & Nierhaus, 2022). In reaction to inflammation, CRP levels can rise up to a thousand-fold, and their rise in the blood can occur before pain, fever, or other clinical signs. The test gauges CRP levels in the blood and can be useful in spotting acute inflammation or keeping track of disease activity in chronic inflammation (Carbo et al., 2016).

Infections, in particular, can enter the urinary system through the urethra while also allowing urine to escape (Byron, 2019). Both in men and in women, bacteria live in the urethra and close to the urethral entry, but they are flushed out after micturition (Charles et al., 1974). Women have a closer proximity to the bladder, which allows germs to colonize the bladder more quickly before being eliminated through micturition. Additionally, it was found that the urethral entrance in females lies near the rectum and vaginal cavity, both of which are home to sizable bacterial communities (Skow et al., 2020). Lower UTIs (limited to the bladder) and higher UTIs (pyelonephritis) are separated into uncomplicated and complicated categories, respectively. A normal host with no anatomical or functional abnormalities, who is not pregnant, and who has not been instrumented (for example, with a catheter) is considered to have an uncomplicated UTI. Complexity is applied to all other UTIs (Keren et al., 2015).

The movement of bacteria from the vaginal cavity, rectal opening, and periurethal area into the urethra is facilitated by urogenital manipulations associated with daily activities and medical interventions; however, even if bacteria reach the bladder and multiply to significant numbers, bacterial colonization rarely results in symptoms (Kline & Lewis, 2017). Given the structure of the human body, urinary tract infections (UTIs) are among the most prevalent bacterial illnesses. In fact, given the ongoing microbial attack on our urinary system, we should be astonished that UTIs are not more common. The likelihood that asymptomatic colonization goes away on its own or develops into a symptomatic infection depends on both host and bacterial characteristics. Host variables include anatomical or functional defects, a genetic predisposition, and behaviours (such as sexual activity) that enhance exposure to uropathogens or transfer germs into the bladder. Numerous virulence traits exhibited by bacteria allow the infection to enter and populate the bladder while eluding the human immune system (Geerlings, 2017).

Urinary symptoms and urine cultures showing numbers of a known uropathogen above a specified threshold (typically defined as >1,000 cfu/ml of urine, though thresholds as low as 100 cfu/ml and as high as 100,000 cfu/ml are also used) are used to diagnose UTIs (Torre et al., 2022). However, urinary symptoms and bacteriuria frequently occur separately from one another: Approximately 20% of women who arrive with 'classic' UTI symptoms have negative urine cultures. The urine of apparently healthy, asymptomatic people frequently contains high concentrations of germs (Usman & Syed, 2018). With increasing age and after sexual activity, the likelihood of asymptomatic bacteriuria rises (Chu & Lowder, 2018).

According to Gupta et al. (2017) urinary tract infections (UTIs) are among the most typical bacterial illnesses that people get both outside of hospitals and in the community. Millions of patients worldwide continue to be significantly impacted by UTI, the majority of whom are otherwise healthy women. Recurrences, which affect up to one-fourth of women after a first UTI, are not prevented by antibiotic treatment for acute cystitis (Tenke et al., 2014). Increasing uropathogenic bacterial antibiotic

resistance complicates therapy choices further, requiring novel strategies based on fundamental biology research.

A number of Studies have been carried out on the evaluation of C- reactive protein in UTI patients in various parts of the world. There is however, limited or no documented expository literature on the evaluation of lipid profile in UTI patients in Madonna University Teaching Hospital (MUTH) in recent time.

METHODS

This section presents the detailed methodology employed in the research, including the study area, research design, ethical approval, sample collection, laboratory assays, and statistical analysis. The approach adopted in this study was rigorously structured to ensure validity and reliability while adhering to ethical standards and protocols for conducting research in clinical settings.

Study Area

The study was conducted at Madonna University Teaching Hospital (MUTH) Elele, situated in the Ikwerre Local Government Area of Rivers State, South-South Nigeria. This community hospital is located at geographical coordinates 50402 N and 64909 E. The laboratory work for this study took place in the chemical pathology laboratory of Madonna University Teaching Hospital, which provided the necessary facilities for sample analysis and testing of the research parameters.

Research Design

This research follows an experimental and cross-sectional design, focusing on estimating the levels of C-reactive protein (CRP) in patients diagnosed with urinary tract infections (UTIs) at Madonna University Teaching Hospital, Elele. The cross-sectional nature of the study allowed for the simultaneous collection of data across a defined population at a single point in time. This design is suitable for determining the prevalence of CRP in UTI patients and understanding its clinical relevance in such cases.

Ethical Approval and Considerations

The research was approved by the Ethical Committee of Madonna University, Elele, Rivers State. The ethical standards were maintained throughout the study, in accordance with the Good Clinical Practice (GCP) guidelines, as well as the modified Helsinki Declaration. Ethical approval ensured that the study adhered to all necessary protocols for protecting the rights and welfare of participants. Written informed consent was obtained from each subject prior to participation in the study. Furthermore, participants were assured that their names and medical details would remain confidential, as the study adhered strictly to ethical standards regarding privacy and data protection.

Inclusion and Exclusion Criteria

The inclusion and exclusion criteria were meticulously defined to select a representative sample of patients who would provide meaningful data for the study.

Inclusion Criteria

Subjects included in the study were those with confirmed fungal or bacterial growth on urine culture plates at Madonna University Teaching Hospital. These subjects were diagnosed with UTIs, and their CRP levels were analyzed to assess the association between infection and inflammatory markers.

Exclusion Criteria

Subjects who exhibited no fungal or bacterial growth on the urine culture plates were excluded from the study. These individuals did not meet the diagnostic criteria for

UTI, and thus their inclusion would not have contributed to the research objectives focused on infection-related CRP levels.

Sample Collection

Sample collection followed standardized procedures to ensure the accuracy and integrity of the collected specimens. A total of 5 ml of whole blood was drawn from each participant through venipuncture. The blood was introduced into a plain container, carefully labeled with the participant's age and laboratory number to ensure proper identification. Following collection, the blood samples were allowed to clot and retract naturally. Once the clotting process was complete, the serum (supernatant) was separated by centrifugation at 12,000 rpm for five minutes.

The resulting serum was transferred into an Ependorf tube using a micropipette to avoid contamination or loss of sample material. Each serum sample was then labeled accordingly to ensure traceability. All collected samples were stored at -20°C to preserve their integrity until the time of laboratory analysis.

Laboratory Assay

The laboratory analysis of C-reactive protein (CRP) was performed using the Enzyme-Linked Immunosorbent Assay (ELISA) method. ELISA is a sensitive and widely accepted immunoassay technique used to measure the concentration of CRP in serum samples. The assay involves a series of steps, including antigen-antibody binding, washing, and colorimetric detection, to quantify CRP levels. This method was chosen due to its accuracy, reproducibility, and ability to detect low concentrations of CRP, making it ideal for assessing the inflammatory response in UTI patients.

Statistical Analysis

Data collected from the study were analyzed using the Statistical Package for the Social Sciences (SPSS), version 26, for Windows 10. Descriptive statistics were used to summarize the characteristics of the study population, with results expressed as mean ± standard deviation (SD). The statistical methods applied included the independent Student's T-test to compare two independent groups and one-way analysis of variance (ANOVA) for comparisons among multiple groups. Statistical significance was determined at a p-value of <0.05, with values greater than 0.05 considered not significant. This approach ensured a robust statistical analysis to assess the relationships between CRP levels and UTI patients, and to draw valid conclusions based on the collected data.

RESULTS AND DISCUSSION

The results of the study focus on the C-reactive protein (CRP) levels in different groups of patients with urinary tract infections (UTIs) and the comparison between various bacterial infections, age groups, and control groups.

CRP Levels in Control and UTI Groups

Table 1. C reactive protein of control and patients with UTI

Parameter	Groups	Mean±SD (mg/l)	F	P-value
C-reactive protein (mg/l)	Control (53)	3.08 ±1.28	231.812	0.000*
	UTI infection (52)	20.75±8.35		

The first significant finding of this study was the comparison of CRP levels between UTI patients and the healthy control group. As shown in Table 4.1, the mean CRP level in the control group was 3.08 ± 1.28 mg/L, while the mean CRP level in the UTI group was significantly higher at 20.75 ± 8.35 mg/L. Statistical analysis using the

independent student t-test revealed a p-value of 0.000, indicating a highly significant difference in CRP levels between the two groups. This was further supported by the analysis of variance (ANOVA), which yielded an F-value of 231.812, further demonstrating that the CRP levels in UTI patients were considerably elevated compared to the control group.

The substantial increase in CRP levels in the UTI group reflects a systemic inflammatory response to the infection. C-reactive protein, as an acute-phase reactant, is produced by the liver in response to the presence of inflammation, particularly from bacterial infections such as UTIs. The findings of this study align with the well-established understanding of CRP as a biomarker of acute inflammation, particularly in infections like UTIs that provoke significant immune system activation (Pope & Choy, 2021; McLellan & Hunstad, 2016). The increase in CRP levels suggests that UTIs induce a significant inflammatory response, which can be detected through serum CRP measurements.

CRP Levels in Different Age Groups

Table 2. C reactive protein in different age groups among patients with UTI

Age	CRP (mg/l)	F	P value
1-12 years	20.68±8.87	10.74	0.000
13-18 years	21.75±8.17		
19-65 years	9.75 ±10.03		

In Table 2, the analysis reveals the mean C-reactive protein (CRP) levels across three distinct age groups. The CRP level for the 1-12 years age group was 20.68 ± 8.87 mg/L, for the 13-18 years group it was 21.75 ± 8.17 mg/L, and for the 19-65 years group, it was notably lower at 9.75 ± 10.03 mg/L.

Statistical analysis through Analysis of Variance (ANOVA) demonstrated a statistically significant difference in CRP levels among the three age groups (p = 0.000). The F-value of 10.74 further substantiated these results, indicating a substantial variation in CRP levels between the groups. This suggests that age significantly influences the inflammatory response in urinary tract infections, with younger individuals (1-18 years) showing notably higher CRP levels compared to adults (19-65 years).

These findings underscore the importance of considering age when interpreting CRP levels in clinical practice, particularly in relation to how the immune system's inflammatory response to infection may differ across age groups.

CRP Levels Among Different Bacterial Strains

Table 3. C reactive protein among different bacteria

Bacterial growth	Mean ±SD mg/l
No Growth (A)	3.08±1.28
Escherichia coli (B)	27.93±5.10
Klebsiella pneumonia (C)	12.99± 4.08
Proteus mirabilis (D)	15.51±4.05
Post hoc	
A vs B	0.000
C vs D	0.054
B vs D	0.000

In table 3, the mean CRP level for the No Growth group (A) was 3.08 ± 1.28 mg/L, for Escherichia coli (B) was 27.93 ± 5.10 mg/L, for Klebsiella pneumoniae (C) was 12.99 ± 4.08 mg/L, and for Proteus mirabilis (D) was 15.51 ± 4.05 mg/L. Post hoc analysis results showed the following pairwise comparisons. The comparison

between the No Growth group and Escherichia coli group revealed a significant difference in CRP levels (p = 0.000). The comparison between Klebsiella pneumoniae and Proteus mirabilis showed no statistically significant difference in CRP levels (p = 0.054). The comparison between Escherichia coli and Proteus mirabilis indicated a significant difference in CRP levels (p = 0.000).

Discussion

This study evaluated the levels of C-reactive protein (CRP) in patients diagnosed with urinary tract infections (UTIs) at Madonna University Teaching Hospital. The data provided valuable insights into the role of CRP as a marker of systemic inflammation in UTIs and revealed interesting age-related variations and differences between bacterial pathogens. The following section discusses the implications of these findings.

Inflammatory Response in UTI Patients

The results from this study confirm the established role of CRP as an acute-phase reactant that is produced by the liver in response to inflammation. As expected, CRP levels were significantly elevated in UTI patients compared to the healthy control group. This is consistent with prior research that has shown CRP levels rise in response to infection or tissue damage (Pope & Choy, 2021). The significant increase in CRP in UTI patients reflects the body's immune response to the infection, where CRP helps activate the complement system and facilitate pathogen clearance (Chaudhari et al., 2018). The elevated CRP levels in UTIs are also a reflection of the inflammatory cascade that occurs due to the bacterial infection, where pro-inflammatory cytokines are released, leading to systemic inflammation. This finding underscores the clinical utility of CRP as a reliable biomarker for the diagnosis and monitoring of UTIs, providing clinicians with an objective measure of inflammation that can complement traditional diagnostic methods (McLellan & Hunstad, 2016).

Age-Related Differences in CRP Levels

An interesting aspect of the study was the observation of age-related differences in CRP levels. The younger age groups (1-12 years and 13-18 years) showed significantly higher CRP levels compared to the adult group (19-65 years). This variation in CRP levels can be attributed to several factors, including the development of the immune system and hormonal influences during puberty. As noted by McLellan & Hunstad (2016), children and adolescents have an immune system that is still maturing, which may lead to a more robust inflammatory response in the presence of infection. Moreover, during adolescence, hormonal changes associated with puberty can also influence immune function, potentially contributing to higher levels of CRP. These findings suggest that age should be taken into account when interpreting CRP levels in clinical practice, as younger individuals may exhibit higher CRP levels in response to infections compared to adults (Medina & Castillo-Pino, 2019). This age-related disparity in CRP levels also highlights the importance of age-specific reference ranges for CRP when diagnosing and managing infections in pediatric and adolescent populations.

Variation in CRP Levels by Bacterial Pathogen

The study also compared CRP levels across different bacterial pathogens commonly associated with UTIs, including *Escherichia coli*, *Klebsiella pneumoniae*, and *Proteus mirabilis*. The results showed that patients infected with *E. coli* had the highest CRP levels, followed by those infected with *Proteus mirabilis* and *Klebsiella pneumoniae*. These findings are consistent with previous research, which has shown that *E. coli*, being the most common uropathogen, is often associated with more severe infections and a stronger inflammatory response (Jung & Brubaker, 2019). The significant difference in CRP levels between *E. coli* and the other pathogens (e.g., *Proteus*

mirabilis and *Klebsiella pneumoniae*) suggests that the pathogenicity of *E. coli* may be more potent, leading to greater immune activation and consequently higher CRP levels. This is in line with the concept that the virulence of the infecting organism plays a crucial role in determining the extent of the inflammatory response. In contrast, the lack of a significant difference between *Proteus mirabilis* and *Klebsiella pneumoniae* could indicate that the inflammatory response to these two pathogens is more similar, possibly due to their comparable ability to elicit an immune reaction (Byron, 2019).

Pathogen-Host Interactions and Immune Response

The differences in CRP levels between bacterial pathogens may also be explained by variations in the host-pathogen interactions. Bacterial species differ in their virulence factors, which can influence the severity of the infection and the resulting inflammatory response. *E. coli*, for example, possesses several virulence factors, such as adhesins and toxins, which enhance its ability to colonize and invade the urinary tract, leading to more severe infections (Geerlings, 2017). These virulence factors may trigger a stronger immune response, resulting in higher CRP production. On the other hand, *Klebsiella pneumoniae* and *Proteus mirabilis* might have different mechanisms of infection that elicit a less intense immune response, as reflected in the lower CRP levels observed in patients infected with these pathogens. This highlights the complexity of host-pathogen interactions and suggests that CRP levels can provide insights into the severity of the infection and the specific bacterial strain involved (Hickling et al., 2017).

Clinical Implications of CRP as a Diagnostic Tool

The results of this study support the use of CRP as a diagnostic tool in clinical settings, particularly for UTIs. The significant elevation in CRP levels among UTI patients compared to controls indicates that CRP can serve as a sensitive biomarker for detecting inflammation associated with UTIs. Additionally, the study's findings regarding age-related variations in CRP levels emphasize the need for age-specific reference ranges in interpreting CRP levels. Clinicians should consider these differences when evaluating CRP in pediatric and adult patients. The data also suggest that CRP may be useful for monitoring disease progression and response to treatment in UTI patients, as CRP levels tend to decrease with successful treatment (Pope & Choy, 2021).

Furthermore, the differences in CRP levels across bacterial species underscore the importance of identifying the causative pathogen in UTIs. Understanding the relationship between CRP levels and specific uropathogens may help clinicians assess the severity of the infection and tailor treatment strategies accordingly. For example, higher CRP levels in *E. coli*-infected patients may warrant more aggressive treatment, while lower CRP levels in *Proteus mirabilis*-infected patients might suggest a less severe infection.

CONCLUSION

This study's findings showed that CRP levels between the control and UTI groups, as well as between various age ranges and bacterial growth categories, differed significantly. The systemic inflammatory response brought on by bacterial infection and tissue damage is reflected in the higher CRP levels in UTIs. CRP levels that vary with age show that immunological responses fluctuate at various developmental stages. Additionally, changes in pathogen virulence and host immune responses are reflected in CRP levels across different categories of bacterial growth. These results help us understand the physiological processes behind the inflammatory response in UTIs and offer important new information for UTI clinical therapy and further research.

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