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C-Reactive Protein and Uric Acid as Prognostic Biomarkers in Chronic Renal Failure: A Hemodialysis-Based Study from Kerbala, Iraq

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P A P E R I N F O

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A b s t r a c t

Background: Chronic kidney disease (CKD) is an important health problem especially in low resource settings with limited access to sophisticated diagnostic facilities. Biochemical and inflammatory parameters, such as creatinine, urea, uric acid, and CRP, might serve as available alternatives for monitoring of the disease.

Methods: A case–control study was carried out at Al-Sadr Medical City, Kerbala, Iraq, comprising 39 hemodialysis patients and 30 gender- and age-matched healthy controls with chronic renal failure. Serum creatinine, urea, uric acid and CRP levels were determined by standard biochemical methods. The CO25 threshold was determined with receiver-operator curves (ROC) analysis, using SPSS software (version 26) and determining the sensitivity and specificity as well as area under the curve (AUC)

Results: The hemodialysis patients had a significantly higher mean level of creatinine (3.04 ± 1.60 mg.dL-1), urea (178.7 ± 96.0 mg.dL-1), uric acid (8.28 ± 3.39 mg.dL-1), and CRP (20.34 ± 2.17 mg.L-1) than the controls ($p < 0.001$). There was a strong positive correlation between CRP and uric acid ($r = 0.542$, $p = 0.002$) and between CRP and urea ($r = 0.54$, $p = 0.003$), while urea correlated with BMI and age ($p \leq 0.005$). ROC analysis showed a very good diagnostic accuracy (AUC/0.97–1.00) for all biomarkers, of which CRP and uric acid were essentially informative predictors.

Conclusion: The results emphasize the interplay between inflammatory and metabolic biomarkers in CKD. High CRP and uric acid not only reflect renal function, but also independently predict cardiovascular outcomes. The integration of these low-cost biomarkers in routine care of dialysis patients may aid in stratifying risk among Iraqi patients. These associations need to be verified by larger, prospective studies.

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1. INTRODUCTION

About 10–13% of the world population is affected by functional incapacitation of the kidney (chronic kidney disease CKD), representing a major public health problem, since it diminishes quality of life and causes premature death (KDIGO, 2024). The economic burden is also substantial with the management of CKD and its complications representing large financial costs for health systems globally. Despite obvious reductions in CVD mortality among the general population, CVD

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continues to account for the greatest proportion of mortality among CKD patients who exhibit a myriad of risk factors such as secondary hyperparathyroidism, increased oxidative stress, heightened sympathetic activity, and endothelial dysfunction manifested by deranged nitric oxide bioavailability and increased endothelin production (Ravarotto et al., 2022)(Wong, 2022).

Pathogenesis-wise, CKD is characterized by a chronic inflammatory condition. The liver is a key organ in the acute phase response, synthesizing proteins such as fibrinogen and C-reactive protein (CRP), and also downregulating transferrin and albumin (Jeena et al., 2022). CRP, as well as other cytokines including IL-6 and TNF-α at higher levels, is not only a marker for systemic inflammation but also an active mediator in endothelial injury and progression of atherosclerosis (Mohallem & Aryal, 2020).In particular, CRP has been identified as a powerful predictor of all-cause and cardiovascular mortality in patients on maintenance hemodialysis (Iseki et al., 1999)(Yeo et al., 2010).However, recent evidence demonstrates that CRP is part of novel inflammatory indices such as the CRP/albumin ratio and CALLY index, both of which are strong predictors of outcome in dialysis patients (Clinical Kidney Journal, 2025).

Besides inflammatory markers, metabolic biomarkers with a strong relation to renal function and cardiovascular risk are crucial. For example, hyperuricemia has been increasingly implicated as a factor contributing to oxidative stress, systemic inflammation, and vascular dysfunction. Nevertheless, the most recent publication of KDIGO 2024 guidelines does not support routine urate-lowering therapy for asymptomatic hyperuricemia in CKD because evidence from randomized trials is unconvincing (KDIGO, 2024).However, high SUA levels have been associated with faster progression of CKD and higher cardiovascular morbidity (Mufti et al., 2022).

Despite these findings, research gaps remain. Most of the studies that have derived the relationships of CRP, UA, and other related biomarkers in CKD have been in Western or Asian subjects, but little information is available on patients in the Middle East, and in particular in Iraq. This is crucial because of the increasing burden of ESRD and the lack of complete dialysis registries in the area (International Society of Nephrology, 2023). Accordingly, this study was carried out to assess the serum levels of CRP, uric acid, urea, and creatinine among patients with chronic renal failure on dialysis in Kerbala, Iraq, and their relation to demographic and clinical characteristics. By addressing the local gap of knowledge, this study aims to contribute to clinical practice and support the risk identification and management of CKD for Iraqi patients.

2. MATERIALS AND METHODS

This case–control study was conducted at Al-Sadr Medical City, Kerbala, Iraq, between April 2022 and January 2023, and included 39 patients with chronic renal failure (CRF) undergoing regular hemodialysis and 30 age- and sex-matched healthy controls. Clinical data (age, sex, body mass index, and blood pressure) were recorded, and venous blood samples were collected prior to dialysis in patients and after overnight fasting in controls. Biochemical analyses included serum creatinine, blood urea nitrogen, uric acid, and C-reactive protein (CRP); CRP was quantified by turbidimetric immunoassay, while other markers were measured using a Siemens Dimension RXL autoanalyzer with appropriate quality control. Statistical analysis was performed using SPSS v26, with data expressed as mean ± standard deviation. Group comparisons were conducted using independent t-tests (or Mann–Whitney U for non-normal data), correlations assessed by Spearman's test, and diagnostic performance evaluated by receiver operating characteristic (ROC) curves; $p \leq 0.05$ was considered statistically significant.

3 .RESULTS

Clinical and biochemical characteristics

Table 1 is a comparison of demographic and biochemical markers between CRF group and healthy control group. There were no statistically significant differences in the mean age of the groups and the BMI. Serum creatinine, urea, uric acid, and CRP were significantly higher in the CRF group than controls ($p < 0.001$). Systolic blood pressure and diastolic blood pressure were also significantly higher in the patient group.

Correlation analysis

Spearman's test revealed in Table 2:

CRP was directly related to serum uric acid ($r = 0.542$, $p = 0.002$), serum urea ($r = 0.54$, $p = 0.003$) and BMI ($r = 0.34$, $p = 0.004$)

Urea showed significant positive correlation with BMI ($r = 0.501$, $p = 0.005$), uric acid ($r = 0.443$, $p = 0.014$) and age ($r = 0.501$, $p = 0.005$)

Non-significant negative associations were also observed between the serum creatinine and urea ($r = -0.045$: $p = 0.814$) and serum uric acid and age ($r = -0.006$: $p = 0.974$).

ROC analysis demonstrated high diagnostic potential of the studied biomarkers in differentiating CRF patients from controls:

CRP: AUC = 1.00 (100% sensitivity, 100% specificity).

Uric acid: AUC = 0.97 (sensitivity = 100%, specificity = 100%).

Urea: AUC = 1.00 (sensitivity = 97%, specificity = 98%).

Creatinine: AUC = 1.00 (sensitivity = 100%, specificity = 100%).

differences in age and BMI were observed between the two groups. The present data highlight the importance of biochemical and inflammatory markers in reflecting both renal dysfunction and systemic inflammation. In particular, the levels of CRP were much higher, confirming the concept of CKD as a condition of chronic low-grade inflammation, associated with endothelial dysfunction, accelerated atherosclerosis, and enhanced cardiovascular risk (Ravarotto et al., 2022), (Clinical Kidney Journal, 2025) . Given that the value of CRP is associated with uric acid and urea, this also correlates with previous findings suggesting a synergistic role of inflammatory activity and metabolic disorders in the pathogenesis of CKD. High CRP has repeatedly been shown to be a powerful risk factor for cardiovascular morbidity and mortality in hemodialysis patients (Iseki et al., 1999), (Yeo et al., 2010), and its predictive performance was recently demonstrated to be particularly meaningful in combination with other components such as the CRP/albumin ratio and the CALLY index, significantly improving risk assessment in dialysis populations (Clinical Kidney Journal, 2025). We also found that hyperuricemia was associated with levels of CRP and urea in our patients. This is consistent with new data indicating that uric acid is not merely an indicator of impaired renal clearance but also induces oxidative and inflammatory pathways, leading to enhanced renal and vascular damage (Jeena et al., 2022), (Mufti et al., 2022). While the KDIGO 2024 guidelines do not recommend long-term urate-lowering therapy (ULT) for asymptomatic hyperuricemia because of inconclusive trial results, elevated SUA remains of clinical importance as a predictor of CKD progression and cardiovascular risk (KDIGO, 2024).Additionally, the significantly increased levels of serum creatinine and urea observed in the dialysis group versus controls serve as an additional confirmation of their usefulness as classical indicators of reduced glomerular filtration. BMI and increasing age were also significantly associated with urea (although not correlated with other clinical measurements), suggesting that metabolic stress and demographic factors influence the magnitude of biochemical disturbances in CKD. These findings are consistent with previous reports showing that raised urea and creatinine are associated with hypertension and increased cardiovascular morbidity (Piccoli et al., 2023), (Rong et al., 2022) Collectively, our results underscore the relationship between inflammation, metabolic disturbances, and renal damage in CRF patients. High CRP and uric acid levels seem to be particularly informative markers in that they not only mirror renal dysfunction but also carry prognostic value in terms of cardiovascular outcomes. These findings emphasize the possibility of including easily identifiable, inexpensive biomarkers in daily dialysis practice in Iraq, where facilities for advanced diagnostic tools are limited. Larger-scale and prospective studies are needed to confirm these findings and to evaluate the predictive role of inflammatory indices on regional levels.

4.CONCLUSION

The present study showed high significant levels of creatinine, urea, uric acid and CRP in patients who had CRF under dialysis when compared to the normal controls. These markers validated the concurrent renal dysfunction and systemic inflammation in patients with CKD. CRP was the most crucial marker, indicative of ongoing inflammation and endothelial damage and predicting cardiovascular events. High uric acid was not only a signal of reduced clearance, but also a driving force for oxidative stress and vascular damage. Significant associations of CRP, uric acid and urea highlight their combined action in the etiology of renal insufficiency. Creatinine and urea also endorsed their classical status of markers of impaired filtration. Urea relationships with BMI and age suggested metabolic and demographic influences. Collectively, these data highlight the importance of low-cost, readily available biomarkers for predicting disease severity. Such predictors are of special interest for developing health care system countries like Iraq. These findings should be confirmed and the predictive value of composite inflammatory indices on CKD outcomes should be investigated in larger prospective trials.

5. ACKNOWLEDGMENTS

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TABLE 1. Clinical and biochemical characteristics of study participants (mean ± SD).

Parameters	Cr. Group	Control Group	P. Value
	Mean ±SD	Mean ±SD	
Age(years) 0.215	47.09±18.75	43.28±14.30	0.215
BMI	26.77±5.10	23.08±4.00	0.24
S. creatinine	3.04±1.60	0.90±0.22	<0.001*
S. urea	178.7± 96.00	22.90 ± 4.24	<0.001*
S. Uric acid	8.28 ± 3.39	4.81 ± 0.84	<0.001*
CRP	20.340± 2.17	0.25± 0.21	<0.001*
BP systolic	140.77±26.84	128.60±16.94	0.001*
BP diastolic	90.83±22.49	81.02±10.50	0.001*

TABLE 2. Spearman correlation coefficients among biochemical markers and clinical parameters in CRF patients.

Parameters		Urea	Uric Acid	Creatinine	CRP
urea	r-Correlation			-.045	-.138
	P-value			.814	.468
Uric acid	r- Correlation	.443*			.542
	P-value	.014			.003
creatinine	r- Correlation	-.045			
	P-value	.814			
CRP	r- Correlation	-.138	.542		
	P-value	.468	.002		
Age	r- Correlation	.501**	-.006		
	P-value	.005	.974		
BMI	r- Correlation	0.58			0.34
	P-value	0.002			0.004*

TABLE 3 : ROC curve analysis for biochemical markers.

Variable	Sensitivity	Specify
CRP	1	1
Urea	0.97	0.98
Uric acid	1	1
Creatinine	1	1

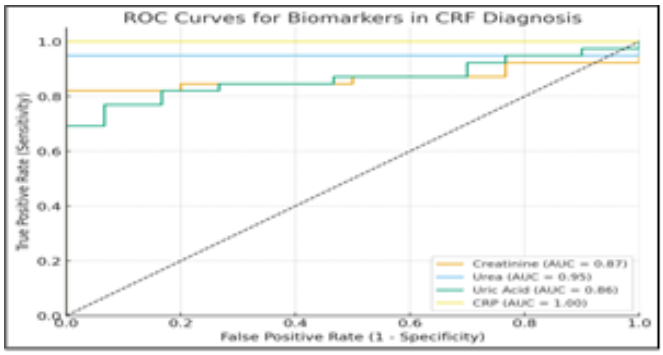

Figure 1. ROC Curves for Biomarkers in CRF Diagnosis

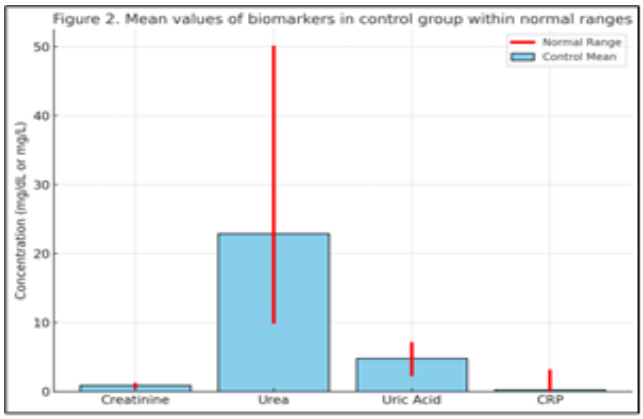

Figure 2. The mean values of creatinine, urea, uric acid, and CRP for the entire control group are within the normal range

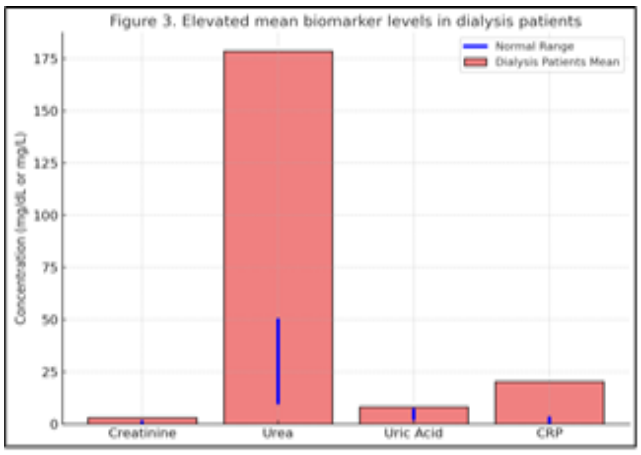

Figure 3. People who are receiving dialysis tend to have higher average levels of creatinine, urea, uric acid, and CRP

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