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RESEARCH ARTICLE

The relationship between infection parameters and urine volume in acute kidney injury

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ABSTRACT

Aim: Acute kidney injury (AKI) is a clinical syndrome that can cause disturbances in fluid-electrolyte and acid-base balance, resulting in the accumulation of nitrogen and uremic toxins along with the loss of kidney functions within hours or days. In this study, it was aimed to retrospectively examine patients with acute kidney injury to determine whether there is a relationship between infection parameters and urine volume.

Materials and Methods: The study included a total of 144 patients with (n=74) and without infection (n=70) out of 294 patients with AKI who received treatment between 1 January 2020 and 31 December 2021 in the nephrology clinic of a tertiary university hospital.

Results: The mean age was 66.4±15.7 (range:19-95) in patients with infection and 63.8±15.2 (range:36- 93) in non-infected patients. 51.4% (n=38) of those with infection and 52.9% (n=37) of those without infection were women. There was no difference between the individuals with and without infection in terms of age and gender (p>0.05). Infection was present in 51.4% (n=74) of the patients included in the study. Urinary tract (31.3%) and respiratory tract infections (13.2%) were the most common in those with infection. A moderate negative correlation was observed between admission CRP and discharge creatinine level in patients with infection. There was no correlation between PCT and sedimentation rate, urine volume and admission/discharge creatinine level. Moderate positive correlations were found between admission/discharge PCT and admission/discharge urine volume in patients without infection. In addition, moderate negative correlations were found between admission/discharge sedimentation rate and admission urine volume.

Conclusions: No correlation was found between PCT and sediment (incoming/exit) and outflow urine volume in patients with infection.

Keywords: acute kidney injury, CRP, PCT, Sedim, urine volume

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INTRODUCTION

Acute kidney injury (AKI) is a clinical syndrome that results in the accumulation of nitrogen and uremic toxins within hours or days of loss of renal function and may lead to disturbance in fluid–electrolyte and acid–base balance (1). AKI is currently a major cause of morbidity and mortality. Its frequency, etiology, prognosis, and mortality vary according to many characteristics of the patients such as age, gender, race, comorbidities, damage to other organs, the stage at the time of diagnosis, and the period in which the studies were conducted (2).

In addition to being a predictor of chronic kidney disease (CKD), AKI is a disease that increases the consumption of health resources (3). While the prevalence of AKI in the general population is below 1%, it rises to 2%–5% in inpatients and 25%–30% in patients in intensive care units (4). Although AKI often manifests as a complex multifactorial syndrome, sepsis, and septic shock are common causes of the disease (5). Inflammation markers are frequently monitored in the diagnosis of infection and treatment management of AKI.

Albumin and prealbumin are negative acute phase reactants synthesized by the liver. In recent years, acute phase reactants such as C-reactive protein (CRP) and procalcitonin (PCT) have been suggested to be potential markers for early diagnosis of infection (6). CRP is a marker synthesized by the liver and its level increases within hours. It is often used because it is cheap and easily accessible. Apart from infections, its levels can be elevated in the presence of cancer, autoimmune diseases, surgery, and trauma (7). PCT, the calcitonin propeptide composed of 116 amino acids with a long half-life in the blood and released from thyroid C cells, has proven to be an early, sensitive, and accurate marker in identifying bacterial infection and assessing the severity of infections and sepsis. PCT concentrations may be elevated in burns, the early stage of trauma, and various non-sepsis conditions, such as invasive surgical interventions (8).

Mehanic et al. reported that PCT is a reliable marker for early diagnosis and evaluation of the prognosis of bacterial infections. However, damage to the kidney or liver may alter the PCT elimination rate and clearance (9).

The aim of this study was to evaluate whether there is a relationship between infection parameters and urine volume in patients with AKI. We think that the results obtained in this study will help clinicians to determine the areas of intervention and priority in preventing the deterioration of AKI.

MATERIALS AND METHODS

This was a single-center retrospective descriptive correlation study. A total of 144 patients with (n=74) and 144 patients without (n=70) infections were included in the study among 294 patients with AKI treated at the nephrology department of a tertiary university hospital between 1 January 2020 and 31 December 2021.

AKI was diagnosed according to Kidney Disease Improving Global Outcomes classification. Patients were evaluated according to the decrease in the amount of urine volume in the first 6 h after hospitalization and the increase in creatinine (Cr) level in 48 h (10).

To determine the source of infection in patients diagnosed with AKI, complete urinalysis and urine culture were performed for urinary tract infections; stool culture was performed for gastrointestinal tract infections; clinical and laboratory tests as well as chest X-rays were used for respiratory tract infections. Clinical evaluation of the patients for the diagnosis of infection was performed daily. The definitive diagnosis of the infection was made by two independent experts based on the clinical and laboratory results.

Patients diagnosed with chronic kidney damage and failure, using drugs, such as angiotensin converting enzyme inhibitors, angiotensin receptor blockers, non-steroidal anti-inflammatory drugs, patients with a history of surgery and trauma in the past week, history of cancer and autoimmune disease, with contrast exposure, hospital stay <48 h, catheter infection, no test results in the last month, <18 years of age, transferred to other clinics, patients who died or discontinued treatment, and those non-compliant with urine collection were not included in the study.

The parameters evaluated in the study were age, gender, length of hospitalization, hemodialysis status, laboratory test results during hospitalization (creatinine, urea, electrolytes, total protein, albumin, hemoglobin, arterial blood pH, and bicarbonate), daily urine volume, and infection parameters (CRP, PCT, and sedimentation rate). Ethics committee approval and institutional permission were obtained (No: 2022/141), and the study was conducted in accordance with the Declaration of Helsinki.

Laboratory analysis

Hemogram tests were performed using Sysmex XN-1000 and biochemistry tests were performed using the Beckman Coulter AU 5800 device. CRP concentrations were measured with immunoturbidimetric method using Beckman Coulter AU 5800. Sedimentation was measured with the Western green method using the Vision C (YHLO, Biotech) device. Procalcitonin was measured with an immunoassay method adapted to the AQT90 Flex analyzer.

Statistical analysis

Data analysis was performed using SPSS version 24.0 statistical software. Descriptive statistics for the variables of the study were presented as numbers (n) and percentages (%). The normality assumption of continuous variables was evaluated using the Kolmogorov-Smirnov test. Continuous variables were presented as mean ($\bar{X}$) ± standard deviation (SD) and median (min-max). Since parametric assumptions were not met, the Mann–Whitney U test was used to compare the means of the two independent groups. Group means were expressed as ($\bar{X}$) ± SD. The correlation between two variables was evaluated using Spearman's rank correlation analysis (coefficient [r]). In all analyses, a p-value <0.05 was considered statistically significant. If there was a significant correlation, the coefficient was evaluated as weak for r = 0-0.24, moderate for r = 0.25–0.49, strong for r = 0.50–0.74, and very strong for r = 0.75-1.00 with a minus (-) sign indicating a negative and plus (+) sign indicating a positive correlation.

RESULTS

The study included 144 patients. The mean age was 66.4 ± 15.7 (min–max: 19-95) in patients with infection and 63.8 ± 15.2 (min-max: 36-93) in patients without infection. Females accounted for 52.9% (n=37) of patients with an infection and 51.4% (n=38) of patients with an infection. There was no difference between patients with and without infection in terms of age and gender (p>0.05). Infection and urine volume parameters of patients with and without infection are presented in Table 1.

Infections were present in 51.4% (n=74) of the patients included in the study. The most common infections were urinary tract (31.3%) and respiratory tract (13.2%) infections (Table 2).

In patients with infections, a moderate negative correlation was observed between admission CRP and discharge creatinine. No correlation was found between PCT and sedimentation (admission/discharge) and discharge urine volume and admission/discharge creatinine (Table 3).

Table 1. Infection and urine volume parameters of patients with and without infection.

	Without infection (n = 70)		**With infection (n = 74)**	
	$\bar{X}$ ± sd		**$\bar{X}$ ± sd**	
	Admission	Discharge	Admission	Discharge
CRP (mg/dL)	0.4±0.1	0.3±0.2	9.0±7.6	1.8±2.1
Sedimentation (mm/h)	44.0±15.9	36.5±15.9	33.7±16.4	18.8±11.2
Procalcitonin (ng/mL)	0.1±0.0	0.1±0.0	2.4±1.0	1.1±0.7
Creatinine (mg/dL)	1.7±0.5	1.0±0.3	4.2±2.5	1.9±1.2
Urine (cc)	1080±269.5	1379.3±286.5	612.8±252.0	1257.6±430.2

Table 2. Infection status of patients.

	N	%
No	70	48.6
Yes	74	51.4
Urinary tract infection	45	31.3
Respiratory tract infection	19	13.2
Soft tissue infection	5	3.5
Bile tract infection	3	2.1
Endocarditis	2	1.4

Moderate positive correlations were found between admission/discharge PCT and admission/discharge urine in patients without infection. Furthermore, moderate negative correlations were observed between admission/discharge sedimentation and admission urine (Table 4).

DISCUSSION

In this study, we evaluated whether there was a change in urine volume as a result of improvement in infection parameters due to the treatment of AKI. No correlation was found between PCT and sedimentation (admission/discharge) and discharge urine volume in patients with infection. In patients without infection, moderate positive correlations were found between admission/discharge PCT and admission/discharge urine volume. In addition, moderate negative correlations were observed between admission/discharge sedimentation and admission urine volume.

Many studies have been conducted on infection parameters such as neutrophil gelatinase-associated lipocalin (NGAL), presepsin, CRP, and PCT in patients with AKI (7,8,11,12). However, there are no studies in the literature evaluating the relationship between infection parameters and urine volume.

In a study conducted by Nakamura et al. evaluating several parameters between sepsis and non-sepsis groups, there was a moderate positive correlation between presepsin and creatinine and also a moderate negative correlation between presepsin and eGFR (13). Another study by Nakamura et al. showed that the diagnostic accuracy of the PCT level was significantly lower in patients with AKI than that of the PCT level in patients without AKI. In addition, there was a significant positive correlation between PCT and creatinine and a negative correlation between PCT and eGFR among patients. These results suggest that the kidneys are one of the organs responsible for eliminating PCT from the blood (14). Meisner et al. reported that renal elimination of PCT is not a major mechanism for the

Table 3. The relationship between infection and urinary parameters in patients with infection.

		$\bar{X}$ ± SD	1	2	3	4	5	6	7	8	9
1	Creatinine (admission)	4.2±2.5 mg/dL	1								
2	Creatinine (discharge)	1.9±1.2 mg/dL	0.769**	1							
3	Urine (admission)	612.8±252.0cc	-0.011	-0.13	1						
4	Urine (discharge)	1257.6±430.2cc	-0.099	-0.242*	0.96**	1					
5	CRP (admission)	9.0±7.6 mg/dL	-0.213	-0.343**	-0.016	0.11	1				
6	CRP (discharge)	1.8±2.1 mg/dL	-0.192	-0.203	-0.057	0.06	0.465**	1			
7	Sedimentation (admission)	33.7±16.4 mm/hour	0.062	-0.049	0.036	0.047	0.217	0.187	1		
8	Sedimentation (discharge)	18.8±11.2 mm/hour	0.081	0.029	0.242*	0.158	0.181	0.227	0.620**	1	
9	Procalcitonin (admission)	2.4±1.0 ng/mL	0.227	-0.082	0.226	0.154	0.103	-0.101	0.049	0.143	1
10	Procalcitonin (discharge)	1.1±0.7 ng/mL	0.11	0.066	0.107	-0.002	0.107	-0.082	0.067	0.146	0.593**

** Correlation is significant at $p < 0.01$.

Table 4. The relationship between infection and urinary parameters in patients without infection.

		$\bar{X}$ ± SD	1	2	3	4	5	6	7	8	9
1	Creatinine (admission)	1.7±0.5 mg/dL	1								
2	Creatinine (discharge)	1.0±0.3 mg/dL	0.577**	1							
3	Urine (admission)	1080±269.5cc	-0.06	-0.004	1						
4	Urine (discharge)	1379.3±286.5cc	0.061	-0.153	0.462**	1					
5	CRP (admission)	0.4±0.1 mg/dL	0.206	0.14	0.23	0.093	1				
6	CRP (discharge)	0.3±0.2 mg/dL	0.137	0.049	0.119	0.12	0.674**	1			
7	Sedimentation (admission)	44.0±15.9 mm/hour	0.281*	0.192	-0.325**	-0.062	0.092	0.167	1		
8	Sedimentation (discharge)	36.5±15.9 mm/hour	0.286*	0.179	-0.328**	-0.093	-0.014	0.173	0.866**	1	
9	Procalcitonin (admission)	0.1±0.0 ng/mL	-0.017	-0.051	0.267*	0.261*	0.084	0.176	-0.094	-0.082	1
10	Procalcitonin (discharge)	0.1±0.0 ng/mL	-0.009	-0.034	0.272*	0.336**	0.062	0.142	-0.123	-0.081	0.944**

** Correlation is significant at $p < 0.01$.

removal of PCT from plasma. The plasma elimination rate may be prolonged up to 30%–50% in some patients with renal dysfunction; since PCT elimination may not be severely affected by this moderate prolongation, the authors concluded that PCT can be used diagnostically in patients with normal renal function as well as in patients with renal failure (15). Nie et al. found that AKI formation, serum creatinine, and cystatin C levels showed a positive correlation with PCT levels (8). In a study by Takahashi et al. investigating the diagnostic accuracy of procalcitonin and presepsin in patients with AKI and infection, higher PCT and presepsin levels were found in patients with infection, and the increase in PCT and presepsin levels was associated with the severity of infection and renal dysfunction. The diagnostic accuracy of PCT and presepsin for infection was not lower in patients with AKI than that in patients without AKI (16). In the present study, no correlation was found between PCT (admission/discharge) and creatinine (admission/discharge) in patients with infection.

Xie et al. found a significant increase in serum CRP levels and a decrease in prealbumin levels in patients with AKI and infection compared to those without infection (17). In the present study, admission CRP level was higher in patients with AKI and infection than that in patients without infection. This result was consistent with the literature.

Since there is no other study in the literature investigating the relationship between PCT, sedimentation, CRP, and urine volume in patients with and without infection, it was not possible to compare the results of the present study with the results of another study.

There are certain limitations to our study. First, this retrospective single-center study included only a small sample size. Second, the effect of the cellular immune status of patients (such as immunosuppressed patients receiving chemotherapy or steroid therapy) on PCT, CRP, and sedimentation levels was not taken into account. Third, other markers of infection (Interleukin-6, myeloid cells-1, Presepsin, and NGAL) were not analyzed due to difficulties obtaining them. In addition, patients with missing data on admission for PCT determination were excluded from the study. Despite these limitations, the results obtained in the present study are important in terms of examining the relationship between infection parameters and urine volume.

As a result, no correlation was found between PCT and sedimentation (admission/discharge) parameters and

urine volume (discharge) in patients with infection. However, a small sample of patients with AKI was evaluated in the present study. We believe that our study will be a pioneer for future multicenter and large-scale studies with large patient groups.

Ethical approval

This study has been approved by the Clinical Research Medical Ethics Committee Dicle University (approval date 12.05.2022, number 2022/141). Written informed consent was obtained from the participants.

Author contribution

Concept: İO, HS, YY; Design: Hİ, YY, EA; Data Collection or Processing: EA, FYA, ZY; Analysis or Interpretation: İO, Hİ, AKK; Literature Search: İO, HS, YY; Writing: İO, HS, EE. All authors reviewed the results and approved the final version of the article.

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Conflict of interest

The authors declare that there is no conflict of interest.

REFERENCES

1. Göçken A, Ayar Y, Yavuz M, Yabacı A. Retrospective Evaluation of the Factors Affecting Etiology and Prognosis of Adult Acute Kidney Injury. Med Bull Haseki. 2020; 58: 216–22. [Crossref]
2. Park WY, Hwang EA, Jang MH, Park SB, Kim HC. The risk factors and outcome of acute kidney injury in the intensive care units. Korean J Intern Med. 2010; 25(2): 181-7. [Crossref]
3. Lameire NH, Bagga A, Cruz D, et al. Acute kidney injury: an increasing global concern. Lancet. 2013; 382(9887): 170-9. [Crossref]
4. Liaño F, Pascual J. Epidemiology of acute renal failure: a prospective, multicenter, community-based study. Madrid Acute Renal Failure Study Group. Kidney Int. 1996; 50(3): 811-8. [Crossref]
5. Parmar A, Langenberg C, Wan L, May CN, Bellomo R, Bagshaw SM. Epidemiology of septic acute kidney injury. Curr Drug Targets. 2009; 10(12): 1169-78. [Crossref]
6. Sipe JD, Cohen AS. Review: history of the amyloid fibril. J Struct Biol. 2000; 130(2-3): 88-98. [Crossref]
7. Gaini S, Koldkjaer OG, Pedersen C, Pedersen SS. Procalcitonin, lipopolysaccharide-binding protein, interleukin-6 and C-reactive protein in community-acquired infections and sepsis: a prospective study. Crit Care. 2006; 10(2): R53. [Crossref]
8. Nie X, Wu B, He Y, et al. Serum procalcitonin predicts development of acute kidney injury in patients with suspected infection. Clin Chem Lab Med. 2013; 51(8): 1655-61. [Crossref]
9. Mehanic S, Baljic R. The importance of serum procalcitonin in diagnosis and treatment of serious bacterial infections and sepsis. Mater Sociomed. 2013; 25(4): 277-81. [Crossref]
10. Kellum JA, Lameire N; KDIGO AKI Guideline Work Group. Diagnosis, evaluation, and management of acute kidney injury: a KDIGO summary (Part 1). Crit Care. 2013; 17(1): 204. [Crossref]
11. Kim H, Hur M, Cruz DN, Moon HW, Yun YM. Plasma neutrophil gelatinase-associated lipocalin as a biomarker for acute kidney injury in critically ill patients with suspected sepsis. Clin Biochem. 2013; 46(15): 1414-8. [Crossref]
12. Nakamura Y, Ishikura H, Nishida T, et al. Usefulness of presepsin in the diagnosis of sepsis in patients with or without acute kidney injury. BMC Anesthesiol. 2014; 14: 88. [Crossref]
13. Nakamura Y, Hoshino K, Kiyomi F, et al. Comparison of accuracy of presepsin and procalcitonin concentrations in diagnosing sepsis in patients with and without acute kidney injury. Clin Chim Acta. 2019; 490: 200-6. [Crossref]
14. Nakamura Y, Murai A, Mizunuma M, et al. Potential use of procalcitonin as biomarker for bacterial sepsis in patients with or without acute kidney injury. J Infect Chemother. 2015; 21(4): 257-63. [Crossref]
15. Meisner M, Lohs T, Huettemann E, Schmidt J, Hueller M, Reinhart K. The plasma elimination rate and urinary secretion of procalcitonin in patients with normal and impaired renal function. Eur J Anaesthesiol. 2001; 18(2): 79-87. [Crossref]
16. Takahashi G, Sh"ibata S, Fukui Y, Okamura Y, Inoue Y. Diagnostic accuracy of procalcitonin and presepsin for infectious disease in patients with acute kidney injury. Diagn Microbiol Infect Dis. 2016; 86(2): 205-10. [Crossref]
17. Xie Q, Zhou Y, Xu Z, et al. The ratio of CRP to prealbumin levels predict mortality in patients with hospital-acquired acute kidney injury. BMC Nephrol. 2011; 12: 30. [Crossref]