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Comparative Study between Platelet-To-Lymphocyte Ratio and Serum Creatinine as Prognostic Indicators in Critically Ill Patients with Acute Kidney Injury

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Abstract

Background: Acute kidney injury (AKI) is a syndrome characterized by a rapid (hours to days) deterioration of kidney function. It is often diagnosed in the context of other acute illnesses and is particularly common in critically ill patients. The clinical consequences of AKI include the accumulation of waste products, electrolytes, and fluid, but also less obvious effects, including reduced immunity and dysfunction of non-renal organs (organ cross-talk). Early diagnosis and management of acute kidney injury is the most effective method for preventing mortality in critically ill patients with acute kidney injury.

Aim of Study: To compare the accuracy of platelet-to-lymphocyte ratio and serum creatinine as predictors of the morbidity and mortality in AKI patients admitted to the intensive care unit (ICU).

Patients and Methods: This study included 155 patients admitted with the diagnosis of AKI or developed AKI during their ICU stay according to the Kidney Disease Improving Global Outcomes guidelines (KDIGO). No patients were excluded from the study. Patients were classified into two groups according to 28-day mortality; Survivors & Non-survivors.

Results: Our study showed a statistically significant difference between platelets to lymphocyte ratio as regards patient outcome, as (79.3%) of the patients with platelets to lymphocyte ratio (>320) required renal replacement therapy in comparison to (52%) of patients with PLR (<90) and (51.5%) of patients with PLR (90 – 320). Also, (82.8%) of the patients with platelets to lymphocyte ratio (>320) required vasopressor use in comparison to (64%) of patients with PLR (<90) and (49.5%) of patients with PLR (90 – 320). Also, (93.1%) of the patients with platelets to lymphocyte ratio (>320) required mechanical ventilation use in comparison to (64%) of patients with PLR (<90) and (39.6%) of patients with PLR (90 – 320). Also, the median of ICU stay was higher among the patients with platelets to lymphocyte ratio (90 – 320) when compared to the other groups.

Conclusion: Both PLR and serum creatinine had sufficient efficacy to predict mortality. PLR had higher ability to predict mortality with higher sensitivity and specificity. It is advised to conduct more studies to investigate the relation between PLR and the need of renal replacement therapy in patients with AKI. PLR could serve as early fair predictor of unfavorable outcomes including need for mechanical ventilation in patients with AKI.

Key Words: *Acute kidney injury – PLR – Serum creatinine – Critically ill.*

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Introduction

ACUTE kidney injury (AKI) is a syndrome characterized by a rapid (hours to days) deterioration of kidney function. It is often diagnosed in the context of other acute illnesses and is particularly common in critically ill patients. The clinical consequences of AKI include the accumulation of waste products, electrolytes, and fluid, but also less obvious effects, including reduced immunity and dysfunction of non-renal organs (organ cross-talk) **[1].**

The impact and prognosis of AKI vary considerably depending on the severity, clinical setting and comorbid factors. There is increasing evidence that AKI is associated with serious short- and long-term complications, in particular increased mortality and morbidity, the development of chronic kidney disease (CKD), and high financial healthcare costs **[2].**

In the presence of AKI, patient mortality increases to as high as 60–70%, especially within 1 year after ICU admission [3]. Considering the high incidence of AKI in the ICU and its poor prognosis, it is vital to detect predictors of AKI and mortality to timely prevent, diagnose and treat this complication.

The current diagnostic approach of AKI is based on an acute decrease of glomerular filtration rate (GFR), as reflected by an acute rise in sCr levels and/or a decline in urine output (UOP) over a given time interval [4]. Recently several biomarkers have been proposed for the diagnosis of AKI and these are in various stages of development and validation [5]. Nevertheless, it is not clear, if a single or multiple biomarker approach is necessary to diagnose the complicated and multifactorial aspects of AKI [6].

Serum creatinine levels are dependent upon age, gender, race, muscle mass and nutritional status and fluid volume status. Interpretation of sCr values is especially difficult in patients with variable degrees of fluid overload, because available measures of body fluid volume are extremely inaccurate in critically ill AKI patients [7]. In spite of its limitations, serum creatinine continues to be an integral part in the measurement and management of renal dysfunction and one of the main determinants in the decision to initiate renal replacement therapies [8]. In addition, it is well known that relatively 'small' increments in sCr are associated with significant increases in the risk of death [9].

Inflammation is one of the central pathophysiological factors in AKI [10]. Leukocytes, including lymphocytes, infiltrate the injured kidneys and the entire body via the circulatory system and induce the generation of inflammatory mediators, which damage the kidney and other organs [11]. Studies have reported that platelets and lymphocytes play critical roles in the inflammatory process [12]. Therefore, the platelet-to-lymphocyte ratio (PLR) has received research attention recently, as an indicator of inflammation in a wide spectrum of diseases, such as myocardial infarction, hepatocellular carcinoma and acute kidney injury (AKI) [13]. It is easily calculated, effective and low-cost marker of systemic inflammation in AKI patients [14].

Aim of the work:

The aim of this study is to compare the accuracy of platelet-to-lymphocyte ratio and serum creatinine as predictors of the morbidity and mortality in AKI patients admitted to the intensive care unit (ICU).

Patients and Methods

Type of study: Prospective observational study

Study setting: Ain Shams University Hospitals (Internal medicine ICU).

Study period: 6 months (March 2024 to September 2024).

Study population:

Inclusion criteria: Age >18 years. Patients admitted with the diagnosis of AKI or developed AKI during their ICU stay according to The Kidney Disease: Improving Global Outcomes guidelines (KDIGO) [15].

Table (1): KIDGO score.

Stage	Serum creatinine	Urine output
1	1.5-1.9 times baseline or ≥0.3mg/dl (≥26.5μmol/l) increase	≤0.5ml/kg/h for 6-12 h
2	2.0-2.9 times baseline	<0.5ml/kg/h for ≥12 h
3	3 times baseline or ≥4.0mg/dl (≥353.6μmol/l) increase or Initiation of RRT or In patients <18 years a decrease in eGFR <35ml/mm/1.73m^2	<0.3ml/kg/h for ≥24 h or Anuria ≥12 h

Exclusion criteria: Patients age <18 years old. Chronic kidney disease patients. Pregnant females. Terminal cancer. Patients with history of renal transplantation. Patients previously diagnosed with blood related disorders.

Sample size:

Using PASS 15 program for sample size calculation, setting power at 80% and alpha error at 0.05 and according to Chen et al., [16], the expected AUROC for PLR for prediction of outcome = 0.726. Assuming a difference of 10% between AUROC fot serum creatinine and PLR, sample size of 155 patients will be needed to detect the difference between two markers regarding their predictive ability.

Ethical considerations:

The purpose, procedure of the study and possible side effects was explained in detail to all selected patients or their first of kin, and an informed

consent was taken from them. Protecting anonymity and confidentiality.

Study tools:

All patients who met the eligibility criteria were subjected to the following:

History Taking on ICU admission: Personal data: name, age, BMI, occupation, address and contact numbers. Past history: with special emphasis on history of hypertension, diabetes mellitus and chronic kidney disease. Drug History: Detailed drug history will be taken focusing on drugs known to cause kidney dysfunction, e.g. NSAIDs, chemotherapy, aminoglycosides, etc...

Complete physical examination: Thorough physical examination was conducted for all patients on admission including vital data (heart rate, blood pressure, mean arterial pressure, temperature, respiratory rate and oxygen saturation) and daily focusing on evaluation of fluid status, signs for acute and chronic heart failure, infection and sepsis.

Laboratory investigations: Complete laboratory investigations was done on admission and as needed during the period of the study including; complete blood picture, blood urea, serum creatinine, electrolytes, coagulation profile, liver enzymes, uric acid, random blood glucose level, and arterial blood gas analysis.

Diagnosis and staging of acute kidney injury: The occurrence of AKI was determined on the basis of KDIGO classification. (Table 1).

Platelet–to-lymphocyte ratio (PLR): The PLR was calculated by dividing absolute platelet count by absolute lymphocyte count **[17]** on admission.

Patients outcome was recorded regarding: Patients were followed-up for 28 days and the following parameters were recorded; length of ICU stay, need for vasopressors, need for mechanical ventilation, need for renal replacement therapy, and 28-day mortality. Patients were classified into two groups according to 28-day mortality; Survivors & Non-survivors. Correlation between PLR & serum creatinine was done in prediction of 28-day mortality. The end point of the study was either patient's death (non survivors) or discharge home before 28 days or completing 28 days in ICU (survivors). Patients who discharged against medical advice were excluded.

Statistical analysis:

Categorical variables will be expressed as numbers and percentages and will be compared between the two groups using contingency tables and χ^2 tests while continuous variables will be expressed as mean and standard deviation (M±SD) and will be compared between the two groups using *t*-tests. Variables associated with *p*-value <0.05 between two groups will be considered statistically significant. The collected data will be revised, coded, tabulated and introduced to a pc using statistical package for social science.

Results

There was statistically significance difference between the two groups regarding diabetes and ischemic heart disease which were significantly higher among the survivors group, and regarding gout, stroke, chronic liver disease, peptic ulcer and peripheral vascular disease were significantly higher among non survivors group.

Table (2): Comparison of comorbidities between survivors and non-survivors.

Variables (n. %)	Survivors (n=101)	Non-survivors (n=54)	*p*-value
Hypertension	71 (70.3%)	38 (70.4%)	0.99
Diabetes mellitus	72 (71.3%)	26 (48.1%)	0.004
Ischemic heart disease	39 (38.6%)	10 (18.5%)	0.01
Atrial fibrillation	17 (16.8%)	8 (14.8%)	0.82
Gout	6 (5.9%)	14 (25.9%)	0.003
Stroke	5 (4.9%)	12 (22.2%)	0.001
Chronic liver disease	5 (4.9%)	10 (18.5%)	0.03
Osteoarthritis	10 (9.9%)	3 (5.6%)	0.38
Bronchial asthma	8 (7.9%)	4 (7.4%)	0.42
COPD	4 (4%)	6 (11.1%)	0.02
Peptic ulcer disease	7 (6.9%)	2 (3.7%)	0.04
Peripheral vascular disease	1 (0.9%)	4 (7.4%)	<0.001

*[1]Chi-square test. Non-significant: $p>0.05$.
[2]Fisher exact test. Significant: $p\leq0.05$.

Table (3): KIDGO score among the studied patients in percentage.

Variables	All patients (n=155)
KIDGO score (n. %):	
1	27 (17.4%)
2	42 (27.2%)
3	86 (55.4%)

*GC S= Glasgow coma score.
KDIGO score = Kidney disease: Improving global outcomes.

Table (4): Heart failure among the studied patients in percentages.

Variables (n. %)	All patients (n=155)
Heart failure:	
No	116 (74.8%)
Acute	18 (11.6%)
Chronic	21 (13.5%)

Table (5): Comparison of patient outcomes between survivors and non-survivors.

Variables	Survivors (n=101)	Non-survivors (n=54)	*p*-value
Renal replacement therapy (n. %):			
No	53 (52.5%)	14 (25.9%)	0.001
Yes	48 (47.5%)	40 (74.1%)	
Vasopressors use (n. %):			
No	65 (64.4%)	6 (12%)	<0.001
Yes	36 (35.6%)	48 (88%)	
Mechanical ventilation use (n. %):			
No	72 (71.3%)	4 (7.4%)	<0.001
Yes	29 (28.7%)	50 (92.6%)	
Length of ICU stay (days):			
Median (IQR)	8 (5)	12 (10.75)	0.51
Range	(3 – 22)	(5– 28)	

*[1]Chi-square test. Non-significant: $p>0.05$.
[2]Fisher exact test. Significant: $p\leq0.05$.
[3]Mann-Whitney test.

There was statistically significant difference between both groups regarding patients' outcome in which morbidities were higher among non survivors group except for ICU stay which was insignificant between both groups.

Table (6): Comparison of Clinical data between survivors and non-survivors.

Variables	Survivors (n=101)	Non-survivors (n=54)	*p*-value
Urine output (/hr):			
Median (IQR)	50 (20)	20 (28.75)	<0.001
Range	(5 – 100)	(10 – 50)	
MAP (mmHg):			
Median (IQR)	70 (15)	55 (15)	<0.001
Range	(50 – 115)	(45 – 80)	
HR (beat/m):			
Median (IQR)	89 (25)	105 (48.75)	0.52
Range	(56 – 130)	(45 – 130)	
Temperature (°C):			
Median (IQR)	37 (1)	37 (0)	0.31
Range	(35 – 38.5)	(37 – 38.5)	
Respiratory rate (breath/m):			
Median (IQR)	20 (7)	20 (7)	0.68
Range	(10 – 28)	(15 – 32)	

*Mann-Whitney U test.
Non-significant: $p>0.05$.
Significant: $p\leq0.05$.

There was statistically significant difference between both groups regarding urine output and MAP, as the survivors had a higher level of urine output and MAP when compared to the non-survivors.

Table (7): Comparison of laboratory data between survivors and non-survivors.

Variables	Survivors (n=101)	Non-survivors (n=54)	*p*-value
TLC ($10^3/mm^3$):			
Median (IQR)	14 (8)	14 (11.5)	0.5
Range	(7 – 45)	(8 – 24)	
CRP (mg/dL):			
Median (IQR)	92 (128)	138 (207)	<0.001
Range	(2 – 295)	(45 – 353)	
Uric acid (mg/dL):			
Median (IQR)	7.5 (3.8)	6.3 (3.3)	0.08
Range	(3 – 12.3)	(2.2 – 12)	
Na (mEq/L):			
Median (IQR)	134 (12)	134 (31.75)	0.91
Range	(114 – 145)	(112 – 154)	
K (mmol/L):			
Median (IQR)	4..6 (1.1)	4.6 (1.5)	0.19
Range	(2.9 – 9.3)	(3.1 – 6.7)	
PTT:			
Median (IQR)	35 (10)	39 (22)	0.006
Range	(26 – 55)	(30 – 65)	
INR:			
Median (IQR)	1.3 (0.4)	1.8 (0.63)	<0.001
Range	(1 – 1.9)	(1.2 – 2.7)	
pH:			
Median (IQR)	7.31 (0.09)	7.29 (0.07)	0.002
Range	(7.1 – 7.67)	(7.22 – 7.55)	
CO2 (mEq/L):			
Median (IQR)	36 (13)	36 (6)	0.74
Range	(26 – 71)	(32 – 48)	
HCO3 (mEq/L):			
Median (IQR)	18 (7)	16 (10)	0.51
Range	(9 – 55)	(12 – 33)	
Urea (mg/dL):			
Median (IQR)	123 (60)	150 (64.5)	0.008
Range	(53 – 213)	(90 – 287)	

*Mann-Whitney U test. Non-significant: $p>0.05$. Significant: $p\leq0.05$.

There was statistically significant difference between both groups regarding laboratory data where CRP, PTT, INR & urea were higher among non survivors group while PH was lower among the same group.

Table (8): Comparison of platelets to lymphocytes ratio and serum creatinine between survivors and non-survivors.

Variables	Survivors (n=101)	Non-survivors (n=54)	*p*-value
Platelets to lymphocytes ratio:			
Median (IQR)	148 (66)	276 (198.5)	<0.001
Range	(23 – 320)	(23 – 512)	
Serum creatinine (mg/dL):			
Median (IQR)	2.5 (1.2)	2.9 (1.85)	0.04
Range	(1.7 – 5.9)	(1.7 – 5.6)	

*Mann-Whitney U test. Non-significant: $p>0.05$. Significant: $p\leq0.05$.

There was statistically significant difference between both groups regarding PLR and serum creatinine as both were higher among non survivors group.

Table (9): Correlation of platelets to lymphocyte ratio and serum creatinine with different parameters among studied patients.

Variable	Platelets to lymphocyte ratio		Serum creatinine	
	r	*p*	*r*	*p*
Age	0.180	0.03	-0.029	0.72
BMI	-0.069	0.39	-0.090	0.27
TLC	-0.141	0.08	-0.134	0.09
CRP	0.344	<0.001	-0.121	0.14
Uric acid	0.101	0.21	0.133	0.09
Na	0.157	0.05	-0.130	0.11
K	-0.061	0.45	0.499	<0.001
PTT	0.106	0.19	0.026	0.75
INR	0.361	<0.001	-0.014	0.86
pH	0.058	0.47	-0.288	<0.001
CO2	0.046	0.57	-0.383	<0.001
HCO3	0.087	0.28	-0.375	<0.001
Urea	0.131	0.11	0.587	<0.001
Urine output	-0.254	0.001	-0.053	0.51
MAP	-0.074	0.36	0.262	<0.001
HR	-0.081	0.32	0.062	0.44
PSO2	-0.032	0.69	0.050	0.54
Temperature	-0.052	0.52	-0.115	0.15
RR	-0.010	0.91	-0.064	0.43
ICU stay	0.124	0.12	0.061	0.45

*[1]Pearson correlation. Non-significant: $p>0.05$.
[2]Spearman rank correlation test. Significant: $p\leq0.05$.

There was a significant positive correlation between platelets to lymphocyte ratio with age, CRP, INR, while there was a significant negative correlation with urine output.

Also, there was a significant positive correlation between serum creatinine with K and Urea, while there was a significant negative correlation with pH, CO_2 and HCO.

Table (10): ROC curve analysis of serum creatinine in differentiating survivors from non-survivors.

Variables	Cut point	Sensitivity (%)	Specificity (%)	PPV (%)	NPP (%)	AUC (%)
Serum creatinine	2.9	51.85%	67.33%	45.9%	72.34%	0.599

On conducting ROC analysis (Receiver operation Curve) to determine the optimal cutoff value to discriminate survivors from non-survivors, the analysis showed that serum creatinine had the highest sensitivity (51.85%) and specificity (67.33%) at 2.9 with area under the curve was (0.599).

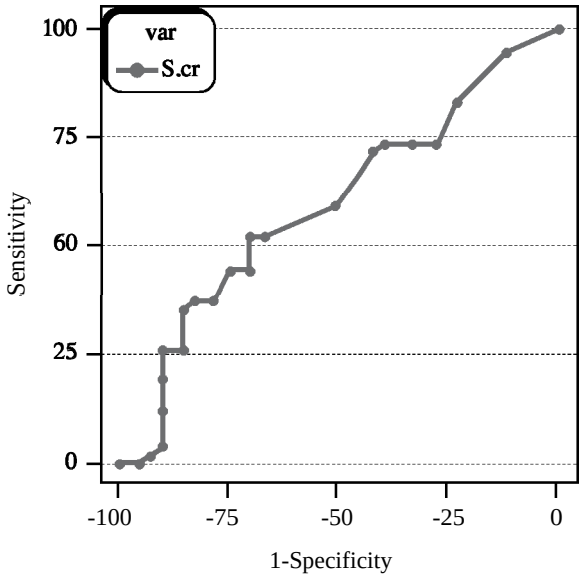

Fig. (1): ROC curve analysis of serum creatinine in differentiating survivors from non-survivors.

Table (11): ROC curve analysis of platelets to lymphocyte ratio in differentiating survivors from non-survivors.

	Cut point	Sensitivity (%)	Specificity (%)	PPV (%)	NPP (%)	AUC (%)
Platelets to lymphocyte ratio	<90	53.33%	100%	100%	58.82%	0.763
	>310	80.95%	100%	100%	66.67%	0.929

On conducting ROC analysis (Receiver operation Curve) to determine the optimal cutoff value to discriminate survivors from non-survivors, the analysis showed that the cut-off value (≤90) had a sensitivity of (53.33%) and specificity (100%) with an area under the curve of (0.763), While the cut-off value (≥310) had a sensitivity of (80.95%) and specificity (100%) with an area under the curve of (0.929).

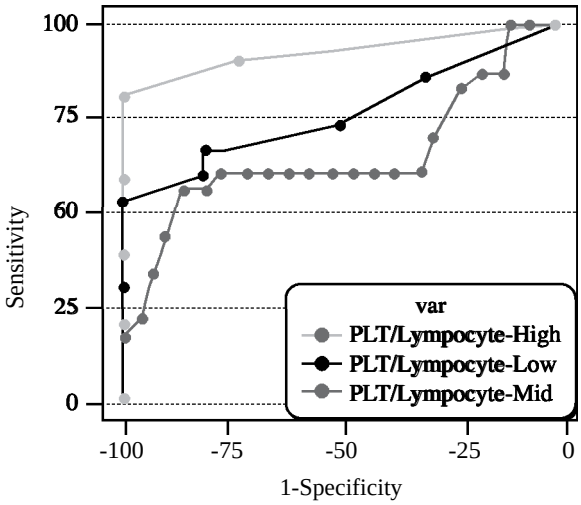

Fig. (2): ROC curve analysis of platelets to lymphocyte ratio in differentiating survivors from non-survivors.

Table (12): Correlation of platelets to lymphocyte ratio and clinical data among studied patients.

Variables	PLR <90 (n=25)	PLR 90 – 320 (n=101)	PLR >320 (n=29)	*p*-value
Urine output (/hr):				
Median (IQR)	50 (35)	40 (30)	30 (25)	0.006
Range	(10 – 100)	(5 – 100)	(10 – 50)	
MAP (mmHg):				
Median (IQR)	65 (15)	65 (20)	60 (10)	0.28
Range	(45 – 115)	(45 – 100)	(45 – 115)	
HR (beat/m):				
Median (IQR)	90 (30)	90 (30)	75 (49)	0.05
Range	(45 – 120)	(45 – 130)	(45 – 130)	
PSO2 (%):				
Median (IQR)	95 (6)	93 (7)	91 (7)	0.19
Range	(85 – 99)	(85 – 97)	(85 – 99)	
Temperature (ºC):				
Median (IQR)	37.4±0.78	37.3 0.49	36.9±0.75	0.03
Range	(35 – 38.5)	(37 – 38.5)	(35 – 38)	
Respiratory rate (breath/m):				
Median (IQR)	19.6±3.57	21.6±3.46	19.5±6.16	0.02
Range	(10 – 25)	(15 – 28)	(10 – 32)	

*[1] One way ANOVA test. Non-significant: $p>0.05$.
[2] Kruscal-Wallis test. Significant: $p\leq0.05$.

There was a statistically significant difference between platelets to lymphocyte ratio as regards urine output, temperature and respiratory rate; as the patients with platelets to lymphocyte ratio (<90) had a higher urine output when compared to other groups (p=0.006). While the patients with platelets to lymphocyte ratio (>320) had a lower heart rate when compared to other groups (p=0.05). While the patients with platelets to lymphocyte ratio (90 – 320) had a higher respiratory rate when compared to other groups (p=0.02).

Table (13): Correlation of platelets to lymphocyte ratio and patient outcome.

Variables	PLR <90 (n=25)	PLR 90 – 320 (n=101)	PLR >320 (n=29)	*p*-value
Renal replacement therapy (n. %):				
No	12 (48%)	49 (48.5%)	6 (20.7%)	0.03
Yes	13 (52%)	52 (51.5%)	23 (79.3%)	
Vasopressors use (n. %):				
No	9 (36%)	51 (50.5%)	5 (17.2%)	0.004
Yes	16 (64%)	50 (49.5%)	24 (82.8%)	
Mechanical ventilation use (n. %):				
No	9 (36%)	61 (60.4%)	2 (6.9%)	<0.001
Yes	16 (64%)	40 (39.6%)	27 (93.1%)	
Length of ICU stay (days):				
Median (IQR)	5 (7)	9 (10)	8 (11)	0.03
Range	(3 – 18)	(3 – 22)	(3 – 17)	

*[1] Chi-square test. Non-significant: $p>0.05$.
[2] Fisher exact test. Significant: $p\leq0.05$.
[3] Kruscall-Wallis test.

There was a statistically significant difference between PLR and patients outcomes, where renal replacement therapy, vasopressors use and mechanical ventilation were higher among patients with PLR >320, While the median ICU stay was higher among patients with PLR (90-320).

Discussion

Patients in the intensive care unit (ICU) generally have high morbidity and mortality rates stemming from acute kidney injury (AKI); here, of all critically ill patients, about 50% with sepsis developed AKI **[18].** AKI is a primary cause of death and disability, especially for those who are already in a severe condition. Inadequate detection of early stages of renal injury continues to be a barrier to the timely diagnosis of AKI. No single biomarker has been universally adopted as an early sign of tubular injury, and the identification of biomarkers for the early detection of AKI is still an ongoing process **[19].**

Developing AKI in critically-ill patient is a deadly complication as it is associated with higher rate of mortality also with prolonged hospital stay, especially with the need for dialysis and risk of developing chronic kidney disease after discharge. AKI forms a burden over the health services' resources **[20].**

Following a comparison of the patient's baseline and maximal creatinine levels within the first seven days of their index intensive care unit stay, AKI was determined to be present. Results from this comparison were based on the KDIGO Clinical Practice Guidelines for Acute Kidney Injury **[21].**

Platelet-to-lymphocyte ratio is a novel, inexpensive, non-invasive biomarker to detect the occurrence of AKI, as there is a strong evidence of the integral role of inflammation in pathogenesis of AKI. Platelets can interact with many cell types including endothelial cells, T-lymphocytes, dendritic cells, neutrophils, and mononuclear phagocytes. These interactions initiate and exacerbate the inflammation in the arterial wall, also recruit leukocytes to the vessel wall leading to release of inflammatory cytokines **[22].**

There is little research on the contribution of the PLR to the prognosis of patients with AKI, and the correlation between the PLR and prognosis of patients with septic AKI has not been examined to date. Therefore, the aim of this study is to compare the accuracy of platelet-to-lymphocyte ratio and serum creatinine as predictors of the morbidity and mortality in AKI patients admitted to the intensive care unit (ICU).

This study included 155 patients admitted with the diagnosis of AKI or developed AKI during their ICU stay according to the Kidney Disease Improving Global Outcomes guidelines (KDIGO). No patients were excluded from the study.

Our study included 155 patients with age ranging from 23 to 90 years and mean of 66.43 years, 54.8% of them were males. Also, Gameiro and Lopes **[23]** identified advanced age as separate risk factor for development of AKI in critically ill patients, and Okba et al. **[24]** studied the relationship between neutrophil to lymphocyte ratio NLR and PLR and AKI prognosis. This study included 102 ICU participants with AKI with mean age 50.1±13.7 years. Most of the included patients were males.

The range of BMI in the studied patients was from 22 to 39.5kg/m^2 and mean of 28.5kg/m^2. In agreement, Sun et al. **[25]** found that BMI was an independent risk factor for the development of AKI in critically ill patients. The association between high BMI and risk of AKI development could be explained by several mechanisms. Obesity causes some hemodynamic changes in the glomerulus such as glomerular hyperperfusion and hyperfiltration may result in glomerular injury. In addition, obesity can increase the hemodynamic and metabolic load on each individual glomerulus, which results in a low number of functional nephrons in obese patients that may result in glomerular hypertrophy and glomerulosclerosis due to increased capillary pressure on the remaining functional nephrons **[26].**

Regarding comorbidities: Hypertension was the most frequent comorbidity, it was found in 70.3% of the patients followed by DM in 63.2% of patients, while 31.6% of them had IHD. In agreement with our study Dylewska et al. **[27]** retrospectively analyzed the medical documentation of 215 patients with AKI and found that Prevalence of hypertension was 70%, with the highest rate in post-renal AKI (85%), followed by renal AKI (75%) and pre-renal AKI (30%). Dialyzed patients were older, had higher blood pressure, and required more hypotensive drugs. In addition, Bennet et al. **[28]** defined the incidence, risk factors and outcomes of AKI in a patient population from the Scottish Hip Fracture Audit database. This study highlights the co-morbidities associated with the development of AKI including, diabetes mellitus, vascular disease, hypertension and pre-morbid chronic renal disease.

Regarding the history of drugs affecting kidney function intake: Aspirin was found in 40% of the patients followed by Angiotensin receptor blockers in 36.8%, Diuretics in 31.6%, while 23.8% of them had NSAIDs. In agreement with our study, Kimachi et al. **[29]** found an association between the prevalent use of ACE inhibitors and AKI incidence. Generally, the incidences of AKI and hyperkalaemia have been reported as the side effects of

the use of ACE inhibitors. In addition, their study revealed the associations of the new use of diuretics, anti-infectious drugs, and contrast media with AKI incidence. However, Pierson-Marchandise et al., [30] found that the most frequently implicated drug classes were antibacterial agents for systemic use (29.5%), diuretics (18.5%), ACE inhibitors (16.3%), antineoplastic agents (10.2%) and anti-inflammatory agents (5.4%).

In our study AKI was the cause of admission in 34.2% of studied patients and the rest of patients developed AKI in the ICU. It was noticed that septic shock was the cause of admission in 13.5% of patients, followed by Myocardial infarction 9.6% and dehydration 7.7%. Uchino et al., [31] reported different result when they conducted Prospective observational study on 29269 critically ill patients in 54 hospital and found 1738 (6.0%) had AKI during their ICU stay, including 1260 were treated with RRT. The most common contributing factor to AKI was septic shock (47.5%).

The KDIGO staging on admission showed that the majority of the patients were in stage 3. In contrast with these findings, Mo et al. [32] who studied incidence of AKI in 2325 ICU patients, 1245 developed AKI during the ICU stay. The incidence in their study according to KDIGO AKI stages 1, 2, and 3 was 26.2, 11.7, and 15.7%, respectively.

Regarding heart failure symptoms in the studied patients, 13.2% of patients had history of chronic heart failure before developing AKI, while 11.6% developed acute heart failure during admission. When heart failure precipitates AKI it is called cardiorenal syndrome type 1. When AKI precipitates heart failure it is called cardiorenal syndrome type 3.

In our study, renal replacement therapy was required for 67 patients (43.2%). In contrast with these findings, Chen et al. [16] investigated the clinical value of the PLR in the prognosis of septic AKI. Of all the 67 patients in AKI group, only 9 patients were not received CRRT. Also, Okba et al. [23] required renal replacement therapy for 26 patients (25.5%).

In our study, vasopressor support was required for 65 patients (41.9%). This was agreed by Aylward et al. [33], who studied development of AKI (before or during ICU admission) with data collected on all patients admitted to a multi-disciplinary ICU in South Africa during 2017, and found (38.8%) of AKI patient in ICU require vassopressor support.

In our study, mechanical ventilation was required for 72 patients (46.5%). Also, Okba et al. [24] required mechanical ventilation for 28 patients (27.4%). A high percent of mechanically ventilated patients was reported among AKI patients in a cross-sectional study conducted in the intensive care unit during the period from July 2018 to June 2019 study by Magboul et al. [34] and stated that stated that most of AKI patients were mechanically ventilated (75.6%).

The length of ICU stay in the current study was (9.23±5.22; [range 3–28]). A lesser ICU stay for AKI patients (6.7±3.8; [range 2–17]) was reported by Magboul et al. [34]. The 28 day mortality in the current study was 38.4%. Aylward et al., [33] also reported high mortality rates reported about 31.8%.

In the current study it was noticed that non-survivors had significantly lower urine output and MAP in comparison to survivors ($p<0.001$). Okba et al. [24] found in their study similar results regarding urine output and MAP.

Chen et al. [16] showed that the prognosis of patients with septic AKI was highly related to factors such as mechanical ventilation, platelet count, the PLR, and arterial blood lactate concentration. In addition, with a Spearman correlation analysis run on the PLR, mechanical ventilation, platelet count, arterial blood lactate concentration, and the non-survival group of AKI with sepsis, the correlation coefficient was −0.225, $p<0.05$ (the PLR); 0.08, $p=0.385$ (mechanical ventilation); −0.219, $p=0.016$ (platelet count); 0.318, $p=0.000$ (arterial blood lactate concentration).

Our study showed a statistically significant difference between survivors and non-survivors as regards platelets to lymphocytes ratio ($p<0.001$), and it was statistically significant higher than serum creatinine (p 0.04). Hudzik et al. [35] reported an association between higher PLR in patient with contrast-induced AKI and mortality in a retrospective analysis of diabetic patients with ST-elevation myocardial infarction ($p<0.0001$).

Our study showed a significant positive correlation between platelets to lymphocyte ratio with age, CRP, INR, while there was a significant negative correlation with urine output. Also, there was a significant positive correlation between serum creatinine with K and urea, while there was a significant negative correlation with pH, CO_2 and HCO3. Umeres-Francia et al. [36] conducted a retrospective cohort study in adults with CKD and reported that PLR had a non-significant correlation with cre-

atinine and a statistically significant positive correlation with hemoglobin. PLR had no significant correlation with other laboratory findings. Okba et al. [23] found a statistically significant positive correlation between serum creatinine and PLR. Abdel Kader et al. [37] studied the relationship between AKI and neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and C3 and C4 levels and found that PLR had significant negative correlation with creatinine.

On conducting ROC analysis (Receiver operation Curve) to determine the optimal cutoff value of serum creatinine to discriminate survivors from non-survivors, the analysis showed that serum creatinine had the highest sensitivity (51.85%) and specificity (67.33%) at 2.9 with area under the curve was (0.599).

On conducting ROC analysis (Receiver operation Curve) to determine the optimal cutoff value of platelets to lymphocyte ratio to discriminate survivors from non-survivors, the analysis showed that the cut-off value (≤90) had a sensitivity of (53.33%) and specificity (100%) with an area under the curve of (0.763), While the cut-off value (≥310) had a sensitivity of (80.95%) and specificity (100%) with an area under the curve of (0.929). A U-shaped relationship was observed between PLR on admission and mortality. The patients in the mid-PLR group (90-310) had the lowest mortality rate when compared with rates in the PLR <90 and PLR >310.

Consistent with our results, Zheng et al. [13] who conducted a study in which 10,859 ICU patients with AKI were enrolled, Thirty-day and ninety-day deaths were calculated and related to PLR, A U-shaped relationship was found between the PLR and both 90-day and 30-day mortality, with the lowest risk at values range (90-311) and the highest at values <90 and >311.

Moreover, Yaprak and colleagues [38] investigated the role between NLR (neutrophil-lymphocyte ratio), PLR, and all-cause mortality in hemodialysis (HD) patients. Results showed that both NLR and PLR were associated with mortality in HD patients, but only PLR independently could predict mortality in those patients, which mean PLR is even better than NLR in predicting mortality in HD patients.

Chen et al. [16] plotted the ROC curve for the PLR and obtained an Area Under the Receiver Operating Characteristic curve (AUROC) value of 0.726. They reported similar sensitivity (70.7%) and specificity (65.4%) PLR values to predict AKI prognosis.

Our study showed a statistically significant difference between platelets to lymphocyte ratio as regards patient outcome, as (79.3%) of the patients with platelets to lymphocyte ratio (>320) required renal replacement therapy in comparison to (52%) of patients with PLR (<90) and (51.5%) of patients with PLR (90 – 320). Also, (82.8%) of the patients with platelets to lymphocyte ratio (>320) required vasopressor use in comparison to (64%) of patients with PLR (<90) and (49.5%) of patients with PLR (90 – 320). Also, (93.1%) of the patients with platelets to lymphocyte ratio (>320) required mechanical ventilation use in comparison to (64%) of patients with PLR (<90) and (39.6%) of patients with PLR (90 – 320). Also, the median of ICU stay was higher among the patients with platelets to lymphocyte ratio (90 – 320) when compared to the other groups.

Okba et al. [24] found that at cutoff value equal of 17.3, PLR had a 92% sensitivity and 89% specificity in the prediction of mechanical ventilation. At cutoff value equal to 1.2, PLR had a 98% sensitivity and 88% specificity in the prediction of shock. At cutoff value of 11.3, PLR had a 96.2% sensitivity and 71.6% specificity in the prediction for the need of dialysis during hospital stay. At cutoff value equal to 1.5, PLR had a 73% sensitivity and 84% specificity in prediction of full recovery.

Bagshaw et al. [39] also supported the theory that the use of mechanical ventilation is closely related to a poor prognosis of patients. Damage caused by positive pressure from mechanical ventilation can be attributed to a large number of inflammatory factors first produced in the lungs that then enter the bloodstream, which eventually damage tissues and organs throughout the body. At about the same time, when there is positive pressure in the thoracic cavity, the amount of blood in the diastolic phase drops, the cardiac volume receptor is excited; when this happens, the sympathetic–adrenal medulla system and the renin–angiotensin aldosterone system are activated, and the release of arginine vasopressin increases. Therefore, for mechanical ventilation treatment in patients with sepsis complicated by AKI, a lung protective ventilation strategy, that is, using a lower tidal volume, is a common approach to improve the optimal positive end expiratory pressure for oxygenation; the fundamental purpose of using a protective ventilation strategy is to reduce lung injury, decrease the production of inflammatory factors, and avoid the function impairment in other organs.

Conclusion:

Early diagnosis and management of acute kidney injury is the most effective method for preventing mortality in critically ill patients with acute kidney injury. Both PLR and serum creatinine had sufficient efficacy to predict mortality. PLR had higher ability to predict mortality with higher sensitivity and specificity. It is advised to conduct more studies to investigate the relation between PLR and the need of renal replacement therapy in patients with AKI. PLR could serve as early fair predictor of unfavorable outcomes including need for mechanical ventilation in patients with AKI.

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دراسة مقارنة بين نسبة الصفائح الدموية إلى الخلايا الليمفاوية ونسبة الكرياتينين بالدم كعوامل تنبؤ بتطور مرضى الحالات الحرجة المصابين بفشل كلوى حاد

القصور الكلوى الحاد (الفشل الكلوى الحاد) هى متلازمة تتميز بالتدهور السريع (من ساعات إلى أيام) فى وظائف الكلى. وغالبا ما يتم تشخيصه فى سياق الأمراض الحادة الأخرى وهو شائع بشكل خاص فى مرضى الحالات الحرجة. هناك أدلة متزايدة على أن الفشل الكلوى الحاد يرتبط بمضاعفات خطيرة قصيرة وطويلة الأجل، ولا سيما زيادة الوفيات والمراضة، وتطور مرض الكلى المزمن، وارتفاع تكاليف الرعاية الصحية المالية. يعد التشخيص المبكر وعلاج القصور الكلوى الحاد الطريقة الأكثر فعالية لمنع الوفيات لدى المرضى المصابين بأمراض خطيرة والذين يعانون من إصابة الكلى الحادة.

الهدف من الدراسة: الهدف من هذه الدراسة هو مقارنة دقة نسبة الصفائح الدموية إلى الخلايا الليمفاوية ونسبة الكرياتينين فى الدم كمتنبئين للمراضة والوفيات لدى مرضى القصور الكلوى الحاد المحجوزين فى وحدة العناية المركزة.

المرضى وطرق البحث: شملت هذه الدراسة ١٥٥ مريضًا تم قبولهم بتشخيص القصور الكلوى الحاد أو حدث لهم قصور كلوى حاد أثناء إقامتهم فى وحدة العناية المركزة وفقًا لإرشادات النتائج العالمية لتحسين أمراض الكلى. ولم يتم استبعاد أى مريض من الدراسة. تم تقسيم المرضى حسب نتائج الدراسة الى مجموعتين ناجين و غير ناجين.

النتائج: أظهرت دراستنا وجود فرق ذو دلالة إحصائية بين نسبة الصفائح الدموية إلى الخلايا الليمفاوية فيما يتعلق بنتائج المريض، حيث أن (٧٩,٣٪) من المرضى الذين لديهم نسبة الصفائح الدموية إلى الخلايا الليمفاوية (< ٣٢٠) يحتاجون إلى علاج غسيل كلوي مقارنة بـ (٥٢٪) من المرضى الذين يعانون من نسبة الصفائح الدموية إلى الخلايا الليمفاوية (<٩٠). كما أن (٨٢,٨٪) من المرضى الذين لديهم نسبة الصفائح الدموية إلى الخلايا الليمفاوية (< ٣٢٠) احتاجوا إلى استخدام ادوية داعمة للدورة الدموية مقارنة بـ (٦٤٪) من المرضى الذين يعانون من نسبة الصفائح الدموية إلى الخلايا الليمفاوية (<٩٠). كما أن (٩٣,١٪) من المرضى الذين لديهم نسبة الصفائح الدموية إلى الخلايا الليمفاوية (< ٣٢٠) يحتاجون إلى استخدام التنفس الصناعي مقارنة بـ (٦٤٪) من المرضى الذين لديهم نسبة الصفائح الدموية إلى الخلايا الليمفاوية (<٩٠). كما أن متوسط الإقامة فى وحدة العناية المركزة كان أعلى بين المرضى الذين لديهم نسبة الصفائح الدموية إلى الخلايا الليمفاوية (٩٠ – ٣٢٠) مقارنة بالمجموعات الأخرى.

الاستنتاجات: كان لكل من نسبة الصفائح الدموية إلى الخلايا الليمفاوية ونسبة الكرياتينين في الدم فعالية كافية للتنبؤ بمعدل الوفيات. كان لدى نسبة الصفائح الدموية إلى الخلايا الليمفاوية قدرة أعلى على التنبؤ بالوفيات بحساسية وخصوصية أعلى. ينصح بإجراء المزيد من الدراسات لمعرفة العلاقة بين نسبة الصفائح الدموية إلى الخلايا الليمفاوية والحاجة إلى العلاج بالغسيل الكلوي لدى المرضى الذين يعانون من القصور الكلوى الحاد.يمكن أن يكون نسبة الصفائح الدموية إلى الخلايا الليمفاوية بمثابة مؤشر مبكر عادل للنتائج الجانبية بما فى ذلك الحاجة إلى التنفس الصناعى فى المرضى الذين يعانون من القصور الكلوى الحاد.