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Red cell distribution width and lactate albumin ratio as prognostic markers for mortality in sepsis and septic shock patients

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Abstract
Background: Red cell distribution Width (RDW) as well as lactate albumin ratio are studied due to their prognostic ability for cases having sepsis. This work was aimed at finding the RDW as well as lactate/albumin ratio utility as prognostic markers among cases having sepsis or septic shock.
Methods: our prospective observational study was carried out on 70 patients whose ages fell between eighteen to sixty yrs., exhibiting clinical criteria either septic shock or sepsis. RDW and lactate albumin ratio on the first, third, seventh, fourteenth, as well as 21st days were measured in all cases.
Results: Lactate/Albumin ratio can significantly predict mortality (P = 0.001 and AUC = 0.751) at cut-off >1.5 with 73.91% sensitivity, 61.70% specificity, 45.57% PPV, 82.86% NPV and 0.420 Youden index J. RDW can significantly predict mortality (P = 0.012 and AUC = 0.698) at cut-off ≥16% with 69.57% sensitivity, 48.94% specificity, 40.00% PPV, 76.67% NPV and 0.436 Youden index J. Lactate/Albumin ratio (AUC=0.751) is the most accurate parameter than lactate, albumin and RDW. Lactate, albumin, lactate/albumin ratio and RDW represented independent significant predictors for septic and septic shock mortality.
Conclusions: In sepsis and septic shock, lactate and albumin, lactate/albumin ratio, and RDW represented independent significant predictors for mortality. However, the lactate/albumin ratio is the most accurate parameter than lactate, albumin, and RDW.

Keywords: Red cell distribution width, lactate albumin ratio, mortality, sepsis, septic shock

Introduction
Sepsis and septic shock represent significant healthcare issues, impacting millions of people annually [1]. Though most septic cases undergo intensive management, including early goal-directed therapy (EGDT), within emergency department (ED), the death rate for sepsis has been shown to exceed 20% to 30% [2].
Many physicians have investigated the blood biomarkers' benefits, involving C-reactive protein (CRP), procalcitonin, as well as lactate for prompt sepsis evaluation and prognostication, thus initiating therapy on time along with avoiding quick progression that could result in multi-organ failure [3].
Multiple indicators are often utilized for sepsis prognosis prediction, involving Acute Physiological and chronic health evaluation II (APACHE II), Sequential Organ Failure Assessment (SOFA), Mortality in Emergency Department Score (MEDS), New York Sepsis severity score [4].
Complete blood count (CBC) is often utilized globally by automated analyzers for cases admitted who could possess higher chances of developing sepsis. RDW represents a CBC report component by automated analyzers. CBC offers many benefits, involving inexpensiveness, availability, as well as a faster turnaround [5]. RDW elevations are observed in many medical diseases, involving congestive heart failure, acute myocardial infarction, pulmonary embolism, pneumonia, critical illness, as well as cardiac. Furthermore, it serves as a prognostic indicator for death among the general population [6].
The lactate/albumin ratio prognostic efficacy exhibits better results as opposed to a single lactate test while predicting 28-day mortality among critically-ill cases with sepsis. Such a ratio ratio proved to be a valuable prognostic indicator, irrespective of the initial lactate level and the presence of hepatic or renal impairment [7].

The RDW predictive values is particularly important since it is often involved in automated CBC analyses for admitted cases, making it readily accessible to physicians without any extra expenses [4].

This research was aimed at investigating utility of RDW as well as lactate/albumin ratio as prognostic indicators for cases with sepsis or septic shock.

Patients and Methods

Our prospective observational study involved seventy cases whose ages fall between eighteen and sixty yrs., exhibiting the sepsis' clinical criteria. The quick sepsis-related organ failure assessment (qSOFA) could be utilized for promptly identifying cases at the bedside who are believed to have an infection. It involves three criteria: mental status' changes, systolic blood pressure less than 100 mmHg, as well as respiration rate above 22/min. Organ dysfunction was diagnosed in cases of sudden rise of 2 or more points in SOFA variables due to the infection. They involve: a PaO2/FiO2 ratio less than 300, a Glasgow Coma Scale score below 15, a mean arterial pressure (MAP) below 70 mmHg, a serum creatinine level above 1.2 mg/dl or a urine output below 0.5 ml/kg/hr, a serum bilirubin level above 1.2 mg/dl, as well as a platelet count below 150 X 103 /µl. The clinical criteria for septic shock involve sepsis accompanied with persisting low blood pressure that necessitates utilizing vasopressors, thus maintaining an MAP above 65 mmHg. Additionally, cases must have a serum lactate level above 2 mmol/L in spite of receiving sufficient volume resuscitation.

This research commenced following the Ethical Committee approval of Tanta University Hospitals, Egypt. All participants or their relatives were asked to fill an informed consent.

We excluded cases receiving a blood transfusion in the last three months prior to emergency admission, those with prolonged disorders that induce anemia involving sickle cell anemia, thalassemia, iron deficiency anemia, malignancy, as well as receiving chemotherapy in the last three months, either hepatic dysfunction, renal failure, cases requiring albumin supplementation, including liver cirrhosis with ascites, nephrotic syndrome, as well as burns.

All participants went through a comprehensive medical history, clinical assessment, lab testing [CBC, CRP, serum lactate, Arterial Blood Gases (ABG), ECG, echocardiogram (ECHO), liver as well as renal function tests, blood culture along with cultures from any areas suspected for infection], RDW and lactate albumin ratio. Sepsids management was accomplished based on surviving sepsis campaign guidelines in 2016 and related update in 2018. All participants went through a categorization into survivor group and the non-survivor group.

Our research's primary outcome was aimed at predicting the 28-day mortality, while secondary ones were ICU stay duration, organ dysfunctions' extent among cases having severe sepsis or septic shock, as well as the association of RDW and lactate albumin ratio values with hospital-based mortality rates.

Sample collection and measurements

Blood was obtained from the peripheral vein, arterial, or central catheter to evaluate whole blood count, serum lactate, as well as serum albumin levels. This procedure was accomplished while diagnosing along with 3, 7, 14, and 21 days of sepsis. All subjects were followed up discharge from hospital or death.

Sample Size Calculation

Utilizing MedCalc ® program version 18.2.1 (MedCalc Software, Ostend, Belgium), The sample size (70 patients) was determined according to these criteria: 0.05 alpha error, 80% power of the study, and 95% confidence limit. According to previous studies, the diagnostic accuracy (AUC of ROC curve) while predicting 28th-day mortality (our primary outcome) reached 0.867 with RDW [8]. And 0.67 with lactate albumin ratio [9]. Four cases were added to overcome dropout.

Statistical analysis

All data went through a statistical analysis utilizing SPSS v 25.0 (Armonk, NY: IBM Corp.).

Quantitative data was displayed as mean as well as standard deviation then went through analysis utilizing a student t-test. Qualitative data was displayed as frequency, as well as percentage then went through analysis utilizing Chi-square or Fisher's exact test. Receiver operating characteristic curve (ROC) was utilized for denoting the test's diagnostic performance. Agreement of the different predictors with the outcome was presented as sensitivity, specificity, positive predictive value, as well as negative predictive value. Pearson correlation was done between two quantitative variables. A two-tailed P value of less than 0.05 was deemed to exhibit a statistical significance.

Results

Regarding our research, we evaluated around ninety-four subjects for eligibility, eighteen cases were not matched with our inclusion requirements, while six disagreed to take part in our research. The rest went through a categorization into two groups, non-survivors' group (n=23) as well as survivors' group (n=47). All participants went through a follow-up period and a statistical analysis. Figure 1.

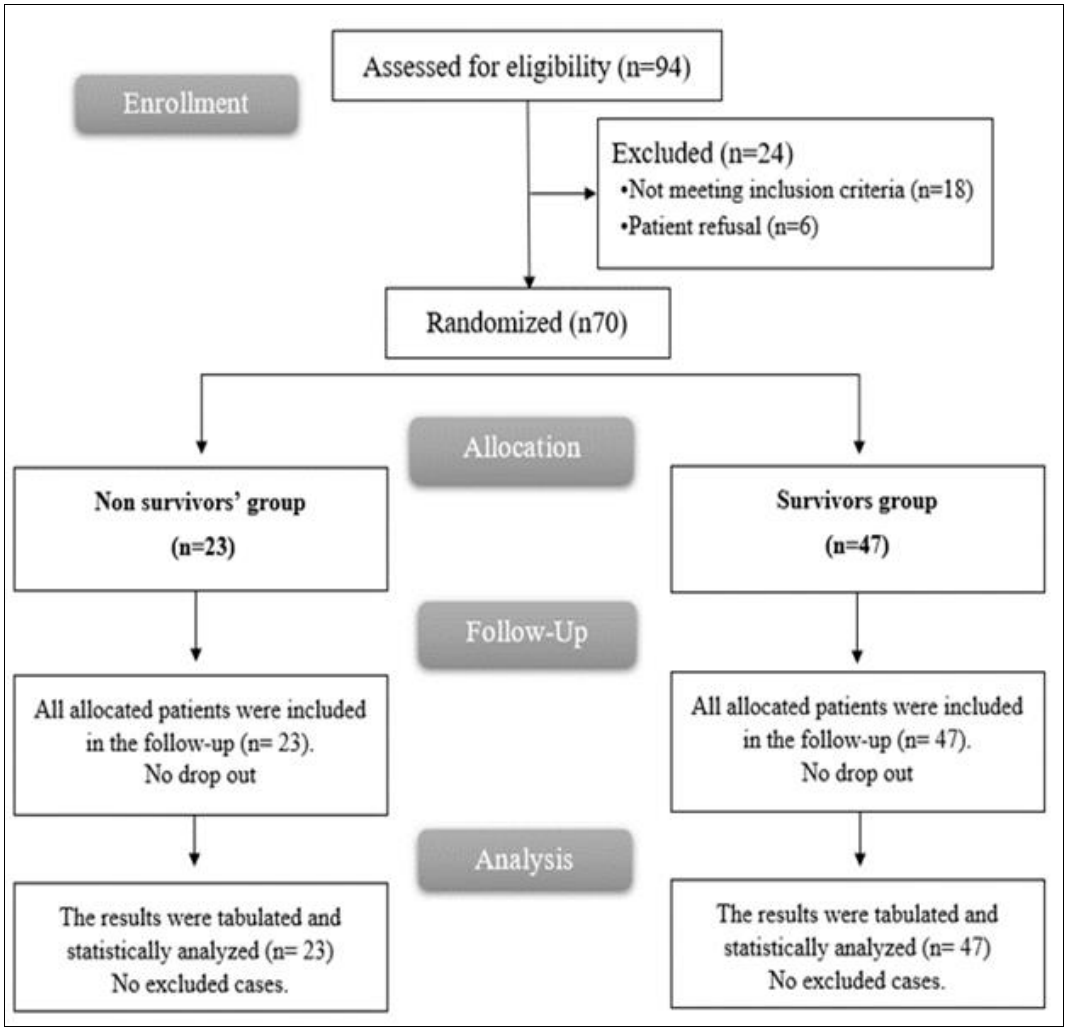

Fig 1: Flowchart of enrolled participants

The age, sex, body mass index (BMI), and the causes of sepsis exhibited insignificant variations among the two groups. The SOFA score, APACHE II, HR, and RR exhibited significant greater values within non-survivors group as opposed to the survivors group (p-value <0.001). The MBP exhibited significant lower values within non-survivors group as opposed to survivors (p-value <0.001). Error! Not a valid bookmark self-reference.

Table 1: Demographic data, causes of sepsis, and vital signs of all groups.

		Non survivors group (n = 23)	Survivors group (n = 47)	P value
Age (years)		51.35 ± 9.93	47.32 ± 9.14	0.097
Sex	Male	12 (52.17%)	28 (59.57%)	0.557
	Female	11 (47.83%)	19 (40.43%)	
BMI (kg/m^2)		30.17 ± 5.54	28.51 ± 5.36	0.235
SOFA score		9.83 ± 1.56	6.34 ± 1.31	<0.001*
APACHE II		27.3 ± 1.92	14.19 ± 3.62	<0.001*
Causes of sepsis				
Intra-abdominal infection		7 (30.43%)	14 (29.79%)	0.964
Chest infection		6 (26.09%)	11 (23.4%)	
CNS infection		5 (21.74%)	8 (17.02%)	
Surgical wound infection		3 (13.04%)	6 (12.77%)	
Urinary tract infection		1 (4.35%)	4 (8.51%)	
Bed sores and central line infection		1 (4.35%)	4 (8.51%)	
Vital signs				
HR (beats/min)		123.04 ± 6.05	96.28 ± 3.87	<0.001*
MBP(mmHg)		61.83 ± 4.44	69.22 ± 5.3	<0.001*
RR (breaths/min)		25.96 ± 3.11	20.57 ± 2.37	<0.001*

Data exhibited as mean ± SD or frequency (%). BMI: Body mass index, *: Statistically significant at $p \leq 0.05$, BMI: Body mass index, SOFA: Sequential organ failure assessment. HR: Heart rate, MBP: Mean blood pressure, RR: Respiratory rate, APACHE: Acute physiology and chronic health evaluation

There was a significant decrease in lactate, lactate albumin ratio, and RDW in survivors' group as opposed to non-survivors on days 1, 3, and 7 of sepsis diagnosis (P value <0.05), and on day 14, there were no data on the non-survivors' group. There was a significant rise in albumin in survivors as opposed to non survivors on day 1, 3, and 7 of sepsis diagnosis (P value <0.05) and day 14there were no data in the non survivors group. Error! Reference source not found.

Table 1: Lactate, albumin, lactate albumin ratio, and RDW measurements of the studied groups

	1st day	3rd day	7th day	14th day	21st day
Lactate (mmol/l)					
Non-survivors group (n = 23)	N=23	N=15	N=10		
	4.9 ± 1.35	6.6 ± 1.25	8.6 ± 1.32	---	---
P# value		<0.001*	<0.001*	---	---
Survivors group (n=47)	N=47	N=47	N=47	N=47	N=47
	3.9 ± 1.29	3.5 ± 1.27	3.1 ± 1.29	2.7 ± 1.28	2.3 ± 1.3
P# value		<0.001*	<0.001*	<0.001*	<0.001*
P## value	0.004*	<0.001*	<0.001*	---	---
Albumin (g/dl)					
Non-survivors group (n=23)	N=23	N=15	N=10		
	2.8 ± 0.56	2.7 ± 0.59	2.4 ± 0.66	---	---
P# value		<0.001*	<0.001*	---	---
Survivors group (n=47)	N=47	N=47	N=47	N=47	N=47
	3 ± 0.26	3.8 ± 0.35	4.7 ± 0.48	5.5 ± 0.54	6.2 ± 0.63
P# value		<0.001*	<0.001*	<0.001*	<0.001*
P## value	0.009*	<0.001*	<0.001*	---	---
Lactate/albumin ratio					
Non-survivors group (n=23)	N=23	N=15	N=10		
	1.9 ± 0.65	2.6 ± 0.84	3.8 ± 1.34	---	---
P# value		<0.001*	<0.001*	---	---
Survivors group (n=47)	N=47	N=47	N=47	N=47	N=47
	1.3 ± 0.43	0.9 ± 0.34	0.7 ± 0.28	0.5 ± 0.24	0.4 ± 0.21
P# value		<0.001*	<0.001*	<0.001*	<0.001*
P## value	<0.001*	<0.001*	<0.001*	---	---
RDW %					
Non-survivors group (n=23)	N=23	N=15	N=10		
	17.8 ± 3.36	17.3 ± 2.66	18.8 ± 1.57	---	---
P# value		<0.001*	<0.001*	---	---
Survivors group (n=47)	N=47	N=47	N=47		
	15.7 ± 1.17	14.7 ± 1.21	13.8 ± 1.19	12.7 ± 1.19	11.7 ± 1.18
P# value		<0.001*	<0.001*	<0.001*	<0.001*
P## value	<0.001*	<0.001*	<0.001*	---	---

Data exhibited as Mean ± SD. # P value compared to 1st day measurement in the same group ## P value among both groups, *: Significant as P value ≤0.05. RDW: Red cell distribution width

The ICU and hospital stay exhibited significant lower values within non survivors as opposed to survivors (P value <0.001). Table 3

Table 2: ICU stay and hospital stay of all groups

	Non-survivors Group (n = 23)	Survivors Group (n = 47)	P value
ICU stay (h)	6.17 ± 4.01	11.77 ± 4.97	<0.001*
Hospital stays (h)	6.17 ± 4.01	14.81 ± 6.05	<0.001*

Data exhibited as Mean ± SD. ICU: Intensive care unit, *: Significant as P value ≤0.05.

Lactate can significantly predict mortality (P = 0.005 and AUC = 0.682) at cut-off ≥4 mmol/l with 65.22% sensitivity, 59.57% specificity, 44.12% PPV, 77.78% NPV and 0.319 Youden index J. Albumin can insignificantly predict mortality (P = 0.095 and AUC = 0.647) at cut-off <3 g/dl with 65.22% sensitivity, 61.70% specificity, 45.45% PPV, 78.38% NPV and 0.395 Youden index J. Lactate/Albumin ratio can significantly predict mortality (P = 0.001 and AUC = 0.751) at cut-off >1.5 with 73.91% sensitivity, 61.70% specificity, 45.57% PPV, 82.86% NPV and 0.420 Youden index J. RDW can significantly predict mortality (P = 0.012 and AUC = 0.698) at cut-off ≥16% with 69.57% sensitivity, 48.94% specificity, 40.00% PPV, 76.67% NPV and 0.436 Youden index J. Figure 2.

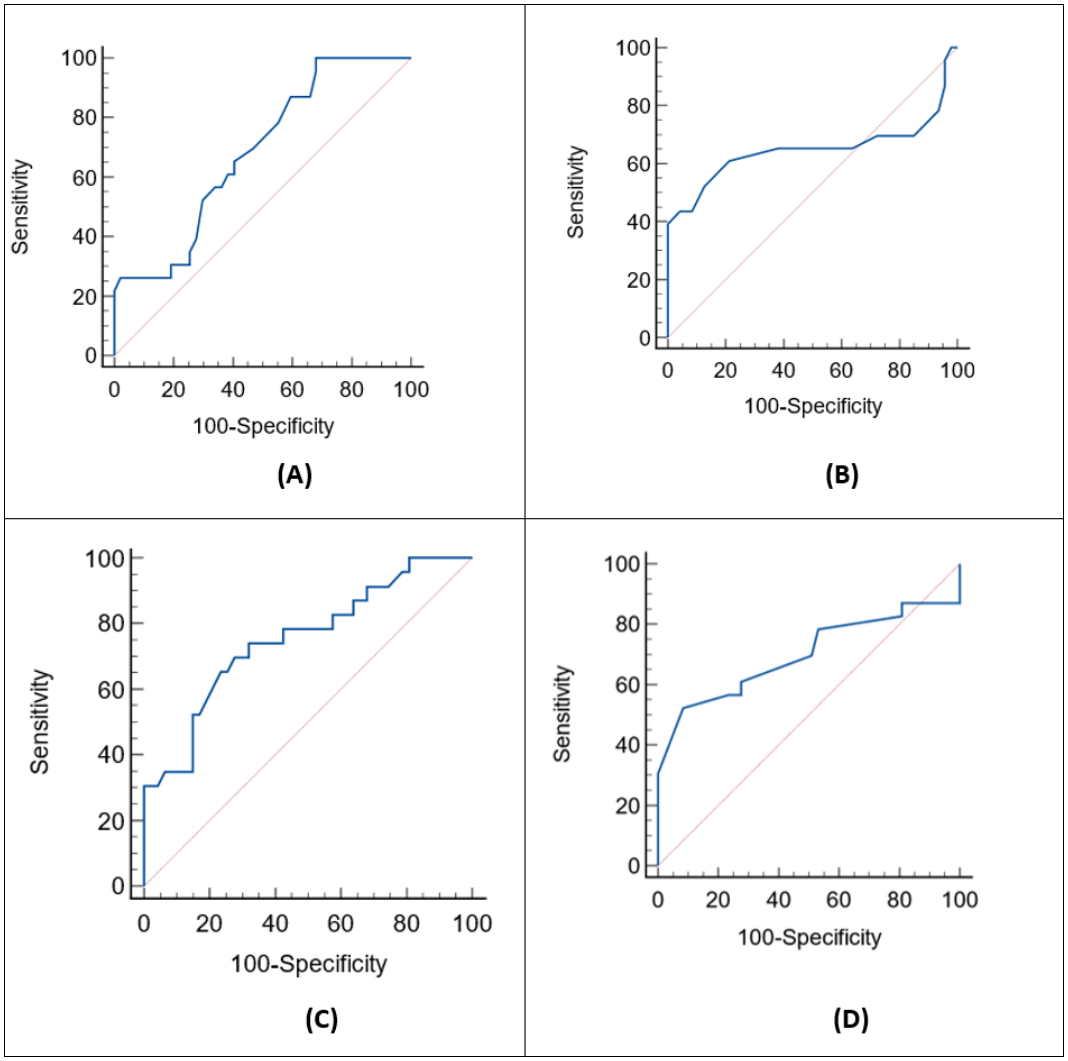

Fig 2: ROC curve of (A) lactate, (B) albumin, (C) lactate/albumin ratio, and (D) RDW % as regards mortality prediction

The lactate/Albumin ratio is the most accurate parameter than lactate, albumin, and RDW (AUC=0.751). Figure 3

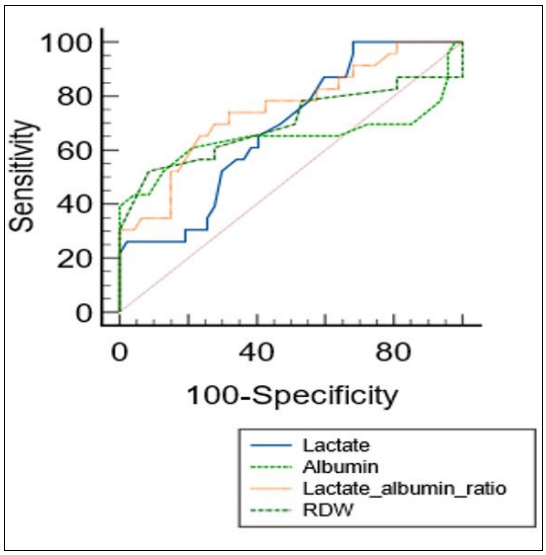

Fig 3: ROC curve of (A) lactate, (B) albumin, (C) lactate/albumin ratio, as well as (D) RDW % regarding mortality prediction

Lactate, albumin, lactate/albumin ratio, and RDW represented independent significant predictors for sepsis and septic shock mortality. Table 4

Table 4: Multivariate regression analysis for mortality prediction

	Coefficient	SE	Wald	P value
Lactate	-7.26	2.81	6.68	0.010*
Albumin	11.62	4.49	6.70	0.010*
Lactate /albumin ratio	23.71	8.76	7.33	0.007*
RDW	0.44	0.18	5.94	0.015*

SE: Standard error *: Significant as P value ≤ 0.05. RDW: Red cell distribution width.

Discussion

Sepsis represents a clinical condition occurring as a result of infections, characterized by widespread inflammation throughout the body. Septic cases could develop organ malfunction, thus potentially inducing life-threatening consequences due to an abnormal immunological response to infections [10].

In the present study, the SOFA score exhibited significant greater values among non-survivors as opposed to survivors (p-value <0.001). Similar to our findings, Li *et al.* [11] they addressed, the mean SOFA scores in patients with clinical sepsis exhibited significant greater values (P<0.05) among non-survivors as opposed to survivors. Supporting our results, Jain *et al.* [12] they revealed that the mean SOFA scores in patients with clinical sepsis was significantly elevated (p<.05) in non-survivors than survivors. Similarly, Moreno-Torres *et al.* [13] they addressed, SOFA exhibited significant greater values in non-found that it showed

significant greater values within mortality group as opposed to improved/cured group (p value =0.002).

Regarding our research, the APACHE II exhibited significant greater values within non-survivors as opposed to survivors (p value <0.001). Li *et al*. [11] addressed that APACHE-II score in septic cases that admitted to the ICU showed significant greater values withsin non-survivors (p<0.01) as opposed to survivors. Supporting our results, Moreno-Torres *et al*. [13] addressed, APACHE-II among septic cases admitted to the ICU exhibited significant greater values within non-survivor group (p<0.01) as opposed to survivor group. Similarly, Ghimire *et al*. [14] also addressed, the APACHE II score showed significant greater values within mortality group as opposed to to improved/cured group (p value = 0.000).

In the present study, the HR and RR exhibited significant greater values within non survivors as opposed to survivors (p value <0.001). However, the MBP showed significant lower values within non survivors group as opposed to survivors' group (p value <0.001). Similarly, Moreno-Torres *et al*. [13] addressed, RR showed significant higher values within non survivors group as opposed to survivors (p value <0.001). However, HR and MBP did not differ between non survivors as well as survivors.

Regarding our research, lactate was significantly higher at the third day, seventh day compared to 1st day in non-survivors (P value <0.001) and significantly less at 3rd day, seventh day as opposed to the first day in survivors (P value <0.001). Similar to our results, Li *et al*. [11] addressed, lactate exhibited significant greater values at 7th day compared to 1st day in non-survivors (P value <0.001) and significantly less at seventh day as opposed to the first day in survivors (P value <0.001). Also, Jeong *et al*. [15] they found that arterial lactate exhibited greater values within non-survivors as opposed to survivors. Similarly, Makram *et al*. [16] they revealed that it was greater among non-survivors, indicating a statistically significant variation (p value <0.001). Additionally, Rabello Filho *et al*. [17] addressed that the greater the blood lactate level among cases with sepsis, the greater chances of mortality.

In the present study, albumin was significantly lower at third day and seventh day compared to 1st day in non-survivors (P value <0.001) and was significantly higher at 3rd day and 7th day compared to 1st day in survivors' group (P value <0.001). Similar to our results, Li *et al*. [11] found that albumin was significantly lower at 7th day compared to 1st day in non-survivors (P value <0.001) and exhibited significant greater values at 7th day compared to 1st day in survivors' group (P value <0.001), which supported Sheng *et al***.** [18] they found that cases having highers albumin levels exhibited lower chances for death at 28-days and 90-days as opposed to others having lowers albumin levels. Supporting our results, Makram *et al*. [16] found that serum albumin on days 0 and 1 showed lower values among non survivors as opposed to survivors, indicating a statistical significance (p values = 0.011 and 0.001 respectively).

In the present study, lactate/albumin ratio showed significant greater values at 3rd day as well as 7th day compared to 1st day in non-survivors (P value <0.001) and was significantly lower values at third day as well as seventh day compared to 1st day in survivors' group (P value <0.001). Similar to our results, Kabra *et al*. [10] they revealed that lactate/albumin ratio exhibited significant greater values within death group than discharge group. The median lactate/albumin ratio within discharge group as well as death group reached 0.64 and 1.27, respectively. Our results came in line with, Jeong *et al*. [15] addressed, lactate/albumin ratio showed greater values within non-survivors' group as opposed to survivors' group. Supporting our results, Makram *et al*. [16] found that levels of lactate/albumin ratio exhibited significant greater values within non survivors (p value<0.001).

Regarding our research, RDW showed significant higher values at third day and seventh day as opposed to the first day among non-survivors (P value <0.001) and was significantly lower at third day, seventh day and fourteenth day compared to 1st day in survivors group (P value <0.001). Similar to our results, Li *et al*. [11] addressed, the levels of RDWCV and RDWSD on both the first day as well as the seventh day exhibited significant greater values and more notably in non-survivor groups than the survivor group. Supporting our results, Jain *et al*. [12] revealed that the mean RDW value at admission exhibited significant greater values among cases having severe sepsis as well as in non-survivors as opposed to survivors (p< .0001). Similarly, Moreno-Torres *et al*. [13] addressed, RDW exhibited significant greater values at 3rd day and seventh day as opposed to 1st day within non-survivors (P value <0.001). RDW 48 as well as 72 h following admission exhibited the greatest observed values at the 1st week after being admitted. Additionally, they represented the strongest mortality predictors. Our results came in line with, Jo *et al*. [19] addressing that the RDW level exhibited significant greater values among non-survival group as opposed to those within the survival one.

In the present study, the ICU stay, and hospital stay exhibited significant lower values within non-survivors as opposed to survivors (P value <0.001). Similar to our findings, Jain *et al*. [12] addressed. the mean stay period in patients with clinical sepsis was significantly elevated (p<.05) in survivors group than non survivors group. Our findings supported, Jeong *et al*. [15] addressing that ICU admission among critically ill cases with pneumonia were significantly greater among survivors as opposed to non survivors at 28 days. In disagreement with our results, Li *et al*. [11] revealed that hospital stay among septic cases was not differ between non-survivors as opposed to survivors (P value <0.001).

In the present study, lactate (mmol/l) can significantly predict mortality (P = 0.005 and AUC = 0.682) at cut-off ≥4 with 65.22% sensitivity, 59.57% specificity, 44.12% PPV, 77.78% NPV and 0.319.

Similar to our results, Kabra *et al*. [10] addressed, lactate significantly predicted the outcome of death. Supporting our results, Li *et al***.** [11] found that lactate levels was independent mortality predictors among septic cases. Additionally, Makram *et al*. [16] documented a strong significant positive association (r - 0.386) between lactate and extent of organ dysfunction (p<0.001). Similarly, Rabello Filho *et al***.** [17] demonstrated that lactate level above 2.5 mmol/L represented ideal threshold while predicting the 28-day mortality among cases having severe sepsis as well as septic shock (ROC area, 0.70; 95% CI, 0.62-0.79), indicating sensitivity, specificity, as well as negative predictive value of 67.4%, 61.7%, and 94.2%, respectively.

In the present study, albumin (g/dl) can insignificantly predict mortality (P = 0.095 and AUC = 0.647) at cut-off <3 with 65.22% sensitivity, 61.70% specificity, 45.45% PPV,

78.38% NPV and 0.395. Supporting our study, Akirov *et al*. [20] addressed that albumin is potentialy useful biomarker in patient with critical illness, the cases having a serum albumin level of below 2.45 g/dl showed the worst mortality outcomes. In disagreement with our results, Sheng *et al*. [18] found that the albumin level was determined as a significant as well as an independent prognostic factor for mortality at 28days and 90days following continuous renal replacement therapy (CRRT) initiation among sepsis cases having acute kidney injury undergoing CRRT. Supporting our findings, Kabra *et al*. [10] addressed, the area under the receiver operating characteristic (AUROC) curve reported that an accurate diagnostic performance was 0.976 while predicting Death versus Discharge for the lactate/Albumin ratio. Supporting our results, Makram *et al*. [16] demonstrated that lactate/albumin ratio represents a valuable biomarker while predicting consequences regarding as regards organ malfunction as well as death for cases having severe sepsis as well as septic shock.

In the present study, RDW % can significantly predict mortality (P = 0.012 and AUC = 0.698) at cut-off ≥16 with 69.57% sensitivity, 48.94% specificity, 40.00% PPV, 76.67% NPV and 0.436. Similar to our findings, Li *et al*. [11] addressed. RDWSD on the 1st day of admission was deemed to be an independent risk factor for the 28-day mortality for cases having sepsis. Supporting our results, Jain *et al*. [12] revealed that RDW could be utilized as a valuable marker for promptly identifying severe sepsis along with predicting its consequences. The area under the receiver operating characteristic curve exhibited 0.852 at a CI of 95% (0.796-0.909) indicating an RDW of 17.15. Additionally, sensitivity reached 88.6%, while specificity exhibited 63.5%. Similarly, Moreno-Torres *et al*. [13] also addressed, RDW represents a hospital mortality prognostic biomarker for cases having sepsis who are admitted to the ICU. AUC-ROC reached 0.827, 0.822, 0.824, 0.834 and 0.812 for each model involving admission, 24, 48 and 72-h and 7-days RDW, respectively. When incorporated into the scores, 24-h RDW as well as admission RDW enhanced their differentiation ability (RDW, p = 0.041; LODS AUC-ROC = 0.687 vs 0.710, p = 0.002). In disagreement with our results, Jeong *et al*. [15] found, greater RDW/albumin ratio exhibits comparative predictive capability to the lactate/albumin ratio for critically ill cases having pneumonia and administering IMV.

In our research, regarding multivariate regression analysis for prediction of mortality, lactate and albumin, lactate/albumin ratio and RDW represented independent significant predictors for mortality among cases having sepsis as well as septic shock. Similar to our results, Li *et al*. [11] found that regarding multivariate Cox regression analyses, RDW (hazard ratio [HR] = 1.107 [95% CI: 1.005–1.219], p = 0.040) and lactate (HR = 112.064 [95% CI: 2.192–5729.629], p = 0.019) represented mortality independent risk factors. Supporting our results, Jain *et al*. [12] revealed that in multivariate logistic regression analyzes, the RDW exhibited independent outcomes' predictors for cases having severe sepsis (P<.05). Similarly, Krishna *et al*. [21] who found that a cox multivariate regression analysis exhibited statistically significant correlation among this RDW increase (p<0.05, HR: 5.6, CI 1.4 to 21.9) as well as mortality.

Limitations: We conducted a single-centered study along with a relatively modest sample size. The disease's severity, cases' characteristics, RDW values, as well as therapy protocols could be varied between institutes, thus impacting the patients' outcomes. RDW is influenced through various conditions, lack of other inflammatory indicators, involving CRP as well as gamma-glutamyl transferase could provide insufficient data as regards the patients' inflammatory status. Additionally, the underlying diseases for each case could induce RDW levels' alterations, we did not perform concomitant conditions' evaluation, involving iron-deficiency anemia, anemia related to chronic kidney disease, hemolytic anemia or B12, folic as well as ferritin levels that could have changed the RDW levels as well as dynamics. Moreover, we did not involve blood transfusions in the multivariate analysis since, based on DAG, transfusion is linked to the hemoglobin levels or the anemia status and could introduce bias.

Conclusions

Lactate and albumin, lactate/albumin ratio and RDW represented independent significant predictors for sepsis as well as septic shock mortality. But, lactate/albumin ratio is the most accurate parameter than lactate, albumin and RDW.

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Conflict of Interest: Nil.

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