Serum Lactate/Albumin Ratio as a Predictor of Morbidity and Mortality in Children and Adolescents with Severe Sepsis and Septic Shock

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ABSTRACT

Background: Sepsis is the 10th leading cause of death and one of the leading causes for admission to the intensive care unit. Combining serum lactate and albumin in the form of lactate albumin ratio could yield more accurate prediction about prognosis of critically ill patients especially in septic patients.
The aim of this work was to to evaluate the ability of Lactate/albumin ratio to predict outcome regarding morbidity, mortality and disease severity.
Methods: This study is done as a case control study that enrolled fifty one critically ill infants and children (cases group), aged from 1 year to 14 years, with the criteria of severe sepsis or septic shock during the duration from October 2023 to March 2024 at Al-Hussein university hospital. 21 healthy infants and children of matched age and sex were included as a control group. All studied patients were subjected to history and examination, laboratory investigations including serum albumin, serum lactate in day 0 and 1 using enzymatic colorimetric, CBC, ESR, CRP, Liver function test and renal function test.
Results: Lactate/albumin ratio at day 0 could significantly predict sepsis with area under the curve of 1, P value <0.001, and at cut-off value >0.16 ng/mL with 100% sensitivity, 100% specificity, 100% positive predictive value (PPV) and 100% negative predictive value (NPV). Lactate/albumin ratio at day 1 could significantly predict sepsis with area under the curve of 0.998, P value <0.001, and at cut-off value >0.12 ng/mL with 100% sensitivity, 85.71% specificity, 94.4% PPV and 100% NPV.
Conclusions: The lactate/albumin ratio could serve as useful biomarkers integrated with a panel for risk-stratification, prognosis and management of paediatric patients with sepsis/septic shock.
Keywords: Serum Lactate/Albumin Ratio, Morbidity, Mortality, Children, Adolescents, Severe Sepsis, Septic Shock.

INTRODUCTION

The incidence and associated mortality and morbidity rates of severe sepsis are commonly underestimated. Sepsis affects more than 750,000 patients each year in the United States; it is the 10th leading cause of death and one of the leading causes for admission to the intensive care unit. The estimated mortality from sepsis is 20–30%, meaning that approximately 500,000 patients survive their septic episode annually in the United States alone. Mounting evidence has demonstrated that survivors of sepsis have a higher long-term risk of death and a lower health-related quality of life when compared with the general population **(Cakir and Turan, 2021)**.

Severe sepsis is defined as sepsis with sepsis induced organ dysfunction or tissue hypoperfusion (manifesting as hypotension, elevated lactate, or decreased urine output). Septic shock is severe sepsis plus persistently low blood pressure despite the administration of intravenous fluids **(Chen et al., 2019)**.

Lactic acid is the normal endpoint of the anaerobic breakdown of glucose in the tissues. The normal blood lactate concentration in unstressed patients is 0.5-1 mmol/L. Patients with critical illness can be considered to have normal lactate concentrations of less than 2 mmol/L. Hyperlactatemia is defined as a persistent, mild to moderate (2-4 mmol/L) increase in blood lactate concentration without metabolic acidosis. Serum lactate is a potentially useful biomarker that is widely investigated in patients with critical illness and give good prognostic values **(Punia Bangar et al., 2022)**.

Albumin is a plasma protein synthesized in the liver. It is the most abundant protein in plasma and constitutes about two-thirds of total protein content. Because it is the main protein in human blood, decreases in albumin due to decreased synthesis or losses result in impaired regulation of intravascular oncotic pressure and manifests as edema. It transports certain hormones (eg, thyroid, estrogen, and cortisol). Serum albumin appears to be a reliable prognostic indicator in various contexts. A recent review suggests that serum albumin could be an independent predictor of mortality in a wide range of clinical and research settings **(Wang et al., 2022)**.

Combining both serum lactate and albumin in the form of lactate albumin ratio could yield more accurate prediction about prognosis of critically ill patients especially in septic patients **(Goto et al., 2022)**.

THE AIM OF THIS WORK

Evaluate the ability of lactate/albumin ratio to predict outcome regarding morbidity, mortality and disease severity.

PATIENTS AND METHODS

This study was done as a case control study that enrolled 51 critically ill infants and children (cases group), aged from 1 year to 14 years old, with the criteria of severe sepsis or septic shock according to The European Society of Intensive Care Medicine (ESICM) **2023**. They were also treated according to Surviving Sepsis Campaign **(Dellinger et al., 2013)** through their hospital stay at Al Azhar University Hospitals. Twenty-one healthy infants and children of matched age and sex were included as a control group.

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Ethical consideration

1. Approved by ethical committee of paediatrics department at the Faculty of Medicine at Al-Azhar university under the registration number was obtained before the study
2. Patients were enrolled in the study after getting informed oral and written consent from their parents
3. Patients data confidentiality was preserved during all study procedures
4. The patients and parents have the right to withdraw any time
5. There was no conflict of interest regarding the study or publication
6. There is no financial support or sponsorship

Sample size equation

The sample size was calculated according to the following equation**.** With 16% standard deviation alpha error of 0.10 &prediction of 90% it included 21 patients for control and 51 patients for study

Necessary Sample Size = (Z-score)^2 × StdDev × (1- StdDev) / (margin of error)^2

Inclusion criteria

1. Age 1 year – 14 years
2. All patients with criteria of severe sepsis or septic shock according to the ESICM is included in this study. They were also treated according to Surviving Sepsis Campaign (International Guidelines for Management of Severe Sepsis and Septic Shock, 2012).

Exclusion criteria

1. Age: < 1year, > 14 years
2. Patients with hepatic dysfunction.
3. Patients with renal failure.
4. Patients with history of albumin supplementation e.g, nephrotic syndrome, burn and liver cirrhosis.

All patients were exposed to:

I. History taking including:
age, gender, weight, co-morbidities (DM, HTN, CVS, HF, renal failure, liver cell failure, and malignancy).

II. Thorough clinical examination:
all patients enrolled in this study were evaluated for vital signs (temperature, heart rate, respiratory rate and MAP), Glasgow coma scale (GCS).

III. Laboratory investigations including :
complete blood count (CBC), differential leucocytic count and serum lactate in day 0 and 1 (mg/dl) using enzymatic colorimetric, liver function test, renal function test, CRP, blood glucose, albumin.

Statistical analysis

Statistical analysis was done by SPSS v26 (IBM Inc., Armonk, NY, USA). Quantitative variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing unpaired Student's t- test. Qualitative variables were presented as frequency and percentage (%) and were analysed utilizing the Chi-square test or Fisher's exact test when appropriate. A two tailed P value $\leq$ 0.05 was considered statistically significant. Evaluation of diagnostic performance was performed using diagnostic sensitivity, specificity, PPV and NPV and the overall diagnostic performance of each test was assessed by roc curve analysis.

RESULTS

Table 1: Demographics data of the studied cases and comorbidities of the studied patients

		Case group (n=51)	Control group (n=21)	P value
Age (years)	**Mean ± SD**	7.4 ± 3.52	7 ± 3.83	0.707
	Range	1 - 14	1 - 13	
Sex	**Male**	33 (64.71%)	13 (61.9%)	0.882
	Female	18 (35.29%)	8 (38.1%)	
Weight (Kg)	**Mean ± SD**	22.7 ± 9.76	22.7 ± 13.58	0.997
	Range	4.5 - 42	4.5 - 45	
Comorbidities	**DM type I**	8 (15.69%)	2 (9.52%)	0.491
	Hypertension	43 (84.31%)	19 (90.48%)	

This table show insignificant difference between cases and control as regarding demographic and comorbidities studies.

Table 2: Etiological diagnosis of studies severe sepsis and septic shock

Etiology	n=51	%
Pneumonia	17	33.3
Gastroenteritis	15	29.4
UTI	13	25.5
Meningitis	6	11.8

This table shows that the most common cause of admitted cases was pneumonia followed by gastro.enteritis

Table 3: Laboratory investigations of the studied patients

			Case group (n=51)	Control group (n=21)	P value
CBC	**RBCs (x10^6 mm^3)**	**Mean ± SD**	3.8 ± 0.79	3.9 ± 0.35	0.869
		Range	2.1 - 4.9	3.1 - 4.5	
	Haemoglobin (g/dL)	**Mean ± SD**	9.6 ± 2.2	14 ± 0.97	**<0.001***
		Range	6.2 - 14.8	12 - 15	
	Haematocrit (%)	**Mean ± SD**	28.5 ± 6.9	34.2 ± 1.21	**<0.001***
		Range	19.6 - 43	32 - 36	
	WBCs (x10^3 mm^3)	**Mean ± SD**	13.1 ± 5.08	10.7 ± 0.84	**0.038***
		Range	4.7 - 29	9.2 - 12.5	
	Neutrophils (%)	**Mean ± SD**	60 ± 20.3	53.4 ± 4.79	0.146
		Range	9.7 - 90	48.3 - 67.3	
	Lymphocytes (%)	**Mean ± SD**	22.7 ± 17.66	22 ± 5.4	0.878
		Range	4 - 71	9 - 26	
	Platelet Count (x10^3 mm^3)	**Mean ± SD**	296.9 ± 184.2	133.6 ± 55.32	**<0.001***
		Range	70 - 782	60 - 230	
Liver function test	**SGPT (IU/ L)**	**Mean ± SD**	45.7 ± 38.03	30.8 ± 23.07	0.099
		Range	9 - 120	11 - 115	
	SGOT (IU/ L)	**Mean ± SD**	63.9 ± 58.7	64 ± 57.12	0.995
		Range	16 - 225	16 - 225	
	Total bilirubin (mg/dL)	**Mean ± SD**	2.1 ± 3.52	0.7 ± 0.91	0.098
		Range	0.11 - 14.6	0.11 - 4.5	
		Mean ± SD	0.6 ± 0.76	0.3 ± 0.39	0.142

	Direct bilirubin (mg/dL)	**Range**	0.02 - 3.1	0.02 - 1.8	
ESR (mm/hr)		**Mean ± SD**	85.1 ± 73.1	5.8 ± 2.06	**<0.001***
		Range	28 - 280	3 - 10	
CRP (mg/dL)		**Mean ± SD**	59.3 ± 57.78	2.1 ± 0.92	**<0.001***
		Range	4.8 - 300	1 - 4	
Glucose (mg/dl)		**Mean ± SD**	95.7 ± 28.69	93.5 ± 16.46	0.745
		Range	47 - 183	47 - 110	
Renal function test	**Urea (mg/dl)**	**Mean ± SD**	17.7 ± 9.42	15.9 ± 7.09	0.431
		Range	3 - 65	3 - 25	
	Creatinine (mg/dl)	**Mean ± SD**	4.6 ± 8.27	0.5 ± 0.2	**0.027***
		Range	0.33 - 23.5	0.33 - 1	

This table show that the cases group had significantly lower haemoglobin and haematocrit, and significantly elevated WBCs, platelet count, ESR, CRP levels, and creatinine levels compared to the control group ($P \leq 0.05$).

Table 4: Lactate/Albumin ratio data of the studied groups

			Case group (n=51)	**Control group (n=21)**	**P value**
Albumin (g/dL)	**Day 0**	**Mean ± SD**	3.8 ± 0.4	3.9 ± 0.41	0.098
		Range	2.9 - 4.61	3.2 - 4.7	
	Day 1	**Mean ± SD**	3.8 ± 0.59	3.8 ± 0.45	0.884
		Range	2.6 - 4.8	3.2 - 4.6	
Lactate (mmol/L)	**Day 0**	**Mean ± SD**	1.5 ± 0.65	0.3 ± 0.14	**<0.001***
		Range	0.6 - 3.9	0.1 - 0.5	
	Day 1	**Mean ± SD**	1.9 ± 0.67	0.3 ± 0.13	**<0.001***
		Range	0.6 - 3.9	0.1 - 0.6	
L/A ratio	**Day 0**	**Mean ± SD**	0.4 ± 0.18	0.1 ± 0.04	**<0.001***
		Range	0.16 - 0.99	0.02 - 0.16	
	Day 1	**Mean ± SD**	0.5 ± 0.23	0.1 ± 0.04	**<0.001***
		Range	0.13 - 1.03	0.02 - 0.15	

L/A: Lactate/albumin. *Significant as P-value ≤ 0.05.

There was no significant difference between the two groups at day 0 and day 1 as regard albumin while lactate levels were significantly elevated in the cases group compared to the control group at day 0 and day 1 ($P<0.001$). Total protein levels were insignificantly different at day 0 between both groups, while they were significantly elevated at day one in the cases group compared to the control group ($P=0.044$). L/A ratio were significantly elevated in the cases group compared to the control group at day 0 and day 1 ($P<0.001$).

Table 5: ICU parameters of the studied groups

		Case group (n=51)	**Control group (n=21)**	**P value**
Glasgow Coma Scale	**Mean ± SD**	13.1 ± 2.13	14.7 ± 0.48	**0.001***
	Range	7 - 15	14 - 15	
Ventilator	**Yes**	12 (23.53%)	0 (0%)	**0.014***
	No	39 (76.47%)	21 (100%)	
Length of stay (Days)	**Mean ± SD**	6.3 ± 1.99	4.7 ± 0.96	**<0.001***
	Range	2 - 11	2 - 6	
Outcome	**Yes**	2 (3.92%)	0 (0%)	1
	No	49 (96.08%)	21 (100%)	

*Significant as P-value ≤ 0.05.

The cases group has significantly lower Glasgow Coma Scale, significantly higher prevalence of ventilated patients, and significantly longer length of stay compared to the control group ($P \leq 0.05$). The outcome was insignificantly different between both groups. **Table 5**

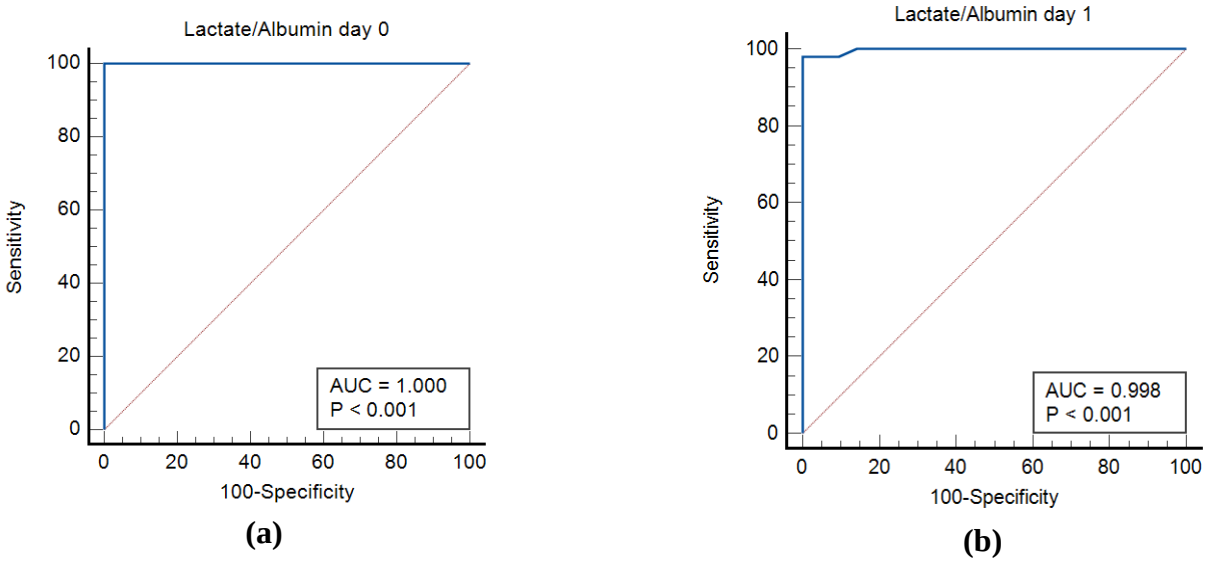

Figure 1: a) lactate/albumin (day0), e) lactate/albumin (day1)

This figure show that lactate/albumin ratio with 100% sensitivity, 85.71% specificity, 94.4% PPV and 100% NPV. **Figure 1**

Table 6: Univariate logistic regression analysis for prediction of mortality

	OR	95% CI	P value
Age (years)	1.2247	0.7778 to 1.9284	0.381
Sex	1.1122	0.7297 to 1.6952	0.621
Weight (Kg)	1.0690	0.9208 to 1.2411	0.381
Comorbidities	1.1958	0.8289 to 1.7250	0.338
Hb (g/dL)	0.5321	0.1891 to 1.4975	0.232
Hct (%)	0.6889	0.3776 to 1.2570	0.224
RBCs (*10^6/mm^3)	3.3072	0.2008 to 54.4583	0.403
PLT (*10^9/L)	1.0020	0.9954 to 1.0087	0.551
WBCs (*10^9/L)	0.6627	0.3880 to 1.1317	0.132
Neutrophils (%)	0.9874	0.9124 to 1.0687	0.754
Lymphocytes (%)	0.8806	0.6908 to 1.1225	0.305
Glucose (mg/dl)	0.9550	0.8873 to 1.0278	0.219
CRP (mg/dL)	1.0018	0.9792 to 1.0249	0.877
ESR (mm/hr)	0.9971	0.9740 to 1.0208	0.809
Serum creatinine (mg/dL)	0.0673	0.0000 to 405.9749	0.543
Urea (mg/dL)	0.9562	0.7884 to 1.1597	0.6492
SGPT (IU/L)	0.3702	0.0908 to 1.5095	0.166
SGOT (IU/L)	0.9438	0.8135 to 1.0949	0.445
Total bilirubin (mg/dl)	0.0310	0.0000 to 31.2328	0.325
Direct bilirubin (mg/dl)	1.2349	0.7699 to 1.9809	0.381
Total protein at day 1 (g/dl)	19.2200	0.3852 to 59.0028	0.138
Albumin at day 1 (g/dl)	3.2681	0.4468 to 40.0986	0.106
Lactate at day (mmol/L)	1.6125	0.3531 to 7.3630	0.537
Lactate/Albumin at day 1	1.0987	0.0069 to 174.4317	0.971
GCS	0.6907	0.4060 to 1.1750	0.172
Ventilator	1.0675	0.9215 to 1.2366	0.384
Length of ICU stay (days)	1.1936	0.6009 to 2.3711	0.613

OR: odds ratio, CI: confidence interval, BMI: body mass index, Hb: hemoglobin, Hct: hematocrit, RBCs: red blood cells, PLT: platelets, WBCs: white blood cells, CRP: C - reactive protein, ESR: erythrocyte sedimentation rate, SGPT: serum glutamic pyruvic transaminase, SGOT: serum glutamic oxaloacetic transaminase, GCS: Glasgow coma scale, ICU: intensive care unit, *: statistically significant as p value ≤ 0.05.

The univariate logistic regression analysis revealed that the parameters in **Table 6** were insignificant predictors of severity of mortality in children and adolescents with severe sepsis and septic shock.

Table 7: Multivariate logistic regression analysis for prediction of mortality

	OR	95% CI	P value
Age (years)	0.9835	0.2078 to 4.6555	0.983
Sex	1.0460	0.6460 to 1.6936	0.998
Weight (Kg)	1.0200	0.6344 to 1.6401	0.935
Comorbidities	1.0357	0.2252 to 4.7638	0.964
Hb (g/dL)	5.1097	0.0337 to 775.0476	0.524
Hct (%)	0.2228	0.0149 to 3.3398	0.277
RBCs (*10^6/mm^3)	0.4090	0.0811 to 2.0630	0.190
PLT (*10^9/L)	0.9897	0.9693 to 1.0106	0.332
WBCs (*10^9/L)	0.5832	0.2844 to 1.1958	0.141
Neutrophils (%)	0.9092	0.7615 to 1.0855	0.292
Lymphocytes (%)	0.6460	0.3138 to 1.3298	0.235
Glucose (mg/dl)	0.9689	0.8812 to 1.0654	0.514
CRP (mg/dL)	1.0187	0.9705 to 1.0693	0.453
ESR (mm/hr)	0.9824	0.9330 to 1.0344	0.500
Serum creatinine (mg/dL)	1.3247	0.7942 to 2.2097	0.451
Urea (mg/dL)	1.0182	0.8625 to 1.2020	0.831
SGPT (IU/L)	0.3347	0.0794 to 1.4112	0.136
SGOT (IU/L)	1.0202	0.9489 to 1.0968	0.588
Total bilirubin (mg/dl)	0.5956	0.2352 to 1.5077	0.274
Direct bilirubin (mg/dl)	0.5930	0.2312 to 1.5209	0.276
Total protein at day 1 (g/dl)	12.8736	0.1636 to 102.797	0.251
Albumin at day 1 (g/dl)	11.9367	0.0962 to 140.947	0.313
Lactate at day 0 (mmol/L)	0.7072	0.0040 to 125.8806	0.896
Lactate/Albumin at day 1	15.7255	1.2455 to 198.5484	**0.033***
GCS	1.0991	1.0228 to 1.1812	**0.010***
Ventilator	0.2987	0.0354 to 2.5205	0.266
Length of ICU stay (days)	1.0906	1.0099 to 1.1778	**0.027***

OR: odds ratio, CI: confidence interval, BMI: body mass index, Hb: hemoglobin, Hct: hematocrit, RBCs: red blood cells, PLT: platelets, WBCs: white blood cells, CRP: C - reactive protein, ESR: erythrocyte sedimentation rate, SGPT: serum glutamic pyruvic transaminase, SGOT: serum glutamic oxaloacetic transaminase, GCS: Glasgow coma scale, ICU: intensive care unit, *: statistically significant as p value ≤ 0.05.

The multivariate logistic regression analysis revealed that Lactate/Albumin at day 1, GCS and length of ICU stay were the only significant predictors of mortality in children and adolescents with severe sepsis and septic shock. **Table 7**

DISCUSSION

In our study, there was no significant difference between the two groups as regard comorbidities.

This disagrees with **(Rabee et al., 2020)** who reported that, the most prevalent comorbidities were DM (51.7%). Respiratory infections were the most common origin encountered (71.3%), followed by the urinary tract infections (47.7%).

In our study, the cases group had significantly elevated WBCs and platelet count compared to the control group ($P \leq 0.05$). There was no significant difference between the two groups as regard lymphocytes.

This slightly agrees with **(Pasaribu et al., 2021)** who found that there was no significant differences were found in lymphocyte counts, and platelets in patients with sepsis and non-sepsis.

In our study, there was no significant difference between the two groups as regard liver function tests (SGPT, SGOT, total bilirubin, and direct bilirubin).

This disagrees with **(Aygün et al., 2020)** who found that there was statistical significant difference between the studied groups regarding ALT, AST, total, direct bilirubin. **(Saini et al., 2022)** showed that liver dysfunction is an early event in sepsis with most children developing sepsis-associated liver injury (SALI) on the same day on which sepsis is diagnosed.

In our study, the cases group had significantly elevated ESR and CRP levels compared to the control group ($P<0.001$).

In our study, there was no significant difference between the two groups at day 0 and day 1 as regard albumin. Lactate levels were significantly elevated in the cases group compared to the control group at day 0 and day 1 ($P<0.001$). Total protein levels were insignificantly different at day 0 between both groups, while they were significantly elevated at day one in the cases group compared to the control group ($P=0.044$). L/A ratio were significantly elevated in the cases group compared to the control group at day 0 and day 1 ($P<0.001$).

This slightly agrees with **(Makram et al., 2020)** who aimed to examine the ability of serum lactate/albumin ratio to predict outcome regarding organ dysfunction and mortality in severe sepsis and septic shock. They found that serum levels of lactate and lactate/albumin ratio were higher in the study group on days 0 and 1 than control group with statistically significant difference (p value< 0.001) whereas serum albumin was significantly lower in the study group on days 0 and 1 than the control group with (p value < 0.001).

This is in disagreement with **(Qian and Liu, 2012)** who concluded that, hypoalbuminemia is common among children with sepsis/severe sepsis/septic shock and serum albumin level is closely related to prognosis.

In our study, the outcome was insignificantly different between both groups (3.92% vs 0%) died in cases group compared to control group. Similar to our results, the increase in sepsis severity was not associated with mortality outcome as in previous pediatric studies who reported that PICU stay was affected by severity of sepsis but not an independent factor of mortality **(Kaur et al., 2014)**.

In our study, the cases group has significantly higher prevalence of ventilated patients, and significantly longer length of stay compared to the control group ($P \leq 0.05$).

In accordance, **(El Gendy et al., 2023)** noticed that; the increase in sepsis severity was associated with increase in the need for mechanical ventilation, and the length of PICU stay.

In our study, the cases group has significantly lower Glasgow Coma Scale, compared to the control group ($P \leq 0.05$).

This is in accordance with **(Rabee et al., 2020)** who found that patients with septic shock had higher SOFA and APACHE II scores compared to sepsis patients, which could validate the use of these scores in assessing the

severity and mortality of our patients. While **(Dabar et al., 2015)** APACHE and SOFA scores were high and did not differ between the two groups.

In our study, the cases group had significantly elevated creatinine levels compared to the control groups (P=0.027).

In our study, Creatinine levels could significantly predict sepsis with AUC of 0.637, P value 0.039, and at cutoff value >0.47 ng/mL with 64.71% sensitivity, 52.38% specificity, 76.7% PPV and 37.9% NPV.

This agrees with **(Elie-Turenne et al., 2012)**, who concluded that creatinine clearance (CrCl), outcome can be reliably predicted in pediatric presentations of sepsis.

In our study, Albumin levels at day 0 and 1 was insignificant predictor of sepsis. Lactate levels at day 0 could significantly predict sepsis with AUC of 1, P value <0.001, and at cutoff value >0.5 ng/mL with 100% sensitivity, 100% specificity, 100% PPV and 100% NPV. Lactate levels at day 1 could significantly predict sepsis with AUC of 1, P value <0.001, and at cutoff value >0.5 ng/mL with 100% sensitivity, 95.24% specificity, 98.1% PPV and 100% NPV. In our study, the univariate logistic regression analysis revealed that Lactate (mmol/L) at day 1 and Albumin at day 1 (g/dl) were insignificant predictor of severity of mortality in children and adolescents with severe sepsis and septic shock. The multivariate logistic regression analysis revealed that Lactate (mmol/L) at day 1 and Albumin at day 1 (g/dl) were insignificant predictor of severity of mortality in children and adolescents with severe sepsis and septic shock.

(Makram et al., 2020) reported that, serum lactate was measured in survivors and non survivors and they found that it was higher in non-survivor group with a statistically significant difference (p value < 0.001). Serum albumin was lower in non survivors than survivors with a statistically significant difference on days 0 and 1 (p= 0.011 and -0.001 respectively).

This was in disagreement with **(Filho et al., 2016)** who found that the higher the blood lactate level in septic patients the higher probability of mortality.

In our study, Lactate/albumin ratio at day 0 could significantly predict sepsis with AUC of 1, P value <0.001, and at cutoff value >0.16 ng/mL with 100% sensitivity, 100% specificity, 100% PPV and 100% NPV. Lactate/albumin ratio at day 1 could significantly predict sepsis with AUC of 0.998, P value <0.001, and at cutoff value >0.12 ng/mL with 100% sensitivity, 85.71% specificity, 94.4% PPV and 100% NPV. In our study, the univariate logistic regression analysis revealed that Lactate/Albumin at day 1 was insignificant predictors of severity of mortality in children and adolescents with severe sepsis and septic shock. The multivariate logistic regression analysis revealed that Lactate/Albumin at day 1, was significant predictors of mortality in children and adolescents with severe sepsis and septic shock.

A meta-analysis by **(Baihaqi et al., 2022)** showed that non-survivor had a higher lactate/albumin ratio than survivor (p <0.001). Higher lactate/albumin ratio was associated with an increased mortality in sepsis and septic shock patients (p <0.001).

(Wang et al., 2022) their logistic regression indicated that L/A ratio levels were independent risk factors for critical illness in children, with L/A ratio showing the strongest association with in-hospital mortality. ROC analysis was performed to evaluate the prognostic value of the L/A ratio levels in children with critical illnesses, which indicated that the overall AUROC of the L/A ratio for predicting in-hospital mortality was higher than that of lactate alone. The results of logistic regression and ROC analysis both can indicate that the L/A ratio has a great value in predicting the prognosis of critical illness in children, superior to lactate and albumin. The overall cut-off value for the L/A ratio in their study was 0.55, demonstrating that patients with an L/A ratio > 0.55 had a worse prognosis.

In our study, the univariate logistic regression analysis revealed that GCS was insignificant predictor of severity of mortality in children

and adolescents with severe sepsis and septic shock. The multivariate logistic regression analysis revealed that GCS was significant predictor of mortality in children and adolescents with severe sepsis and septic shock.

CONCLUSIONS

- The sepsis cases group had significantly higher markers of inflammation and organ dysfunction compared to controls, including elevated WBC count, ESR, CRP, creatinine and lactate levels as well as lower GCS scores.
- The lactate/albumin ratio at day 0 and day 1 was also markedly higher in sepsis cases.
- Lactate levels alone on both day 0 and 1 as well as the lactate/albumin ratio distinguished sepsis cases from controls with 100% sensitivity and specificity.
- Mortality was low overall and did not significantly differ between groups. While lactate and lactate/albumin ratio were not predictors of mortality on univariate analysis, the lactate/albumin ratio and GCS score were identified as significant independent predictors of mortality risk on multivariate logistic regression.

(Shenoy and Patil, 2023) reported that on univariate analysis, high PRISM-III was associated with mortality. However, on multiple logistic regression analysis, high PRISM-III, was the factor found to be independently associated with mortality

- Overall, this study provides evidence that the lactate/albumin ratio, along with GCS assessment, could serve as useful biomarkers integrated into a panel for risk-stratification, prognosis and management of paediatric patients with sepsis or septic shock.

LIMITATIONS

Our study has some limitations as single centre study, relatively small sample size. Short follow up duration.

RECOMMENDATIONS

Further multi centre studies are warranted to confirm utility. Longer follow-up period to validate our findings.

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