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A prospective cohort study of severe sepsis-induced dyslipidemia and changes in D-dimer levels in children: do they affect the prognosis?

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Abstract

Background The dyslipidemia and changes in D-dimer values that occur in children with severe sepsis remain unidentified.

Objective The current research aimed to explore the relationship between D-dimer and lipid profile values, including total cholesterol (TC), lipoproteins, apolipoprotein A-V (Apo A-5), triglycerides (TG), and in-hospital nonsurvival in children with severe sepsis or septic shock in pediatric intensive care.

Study design The study design is as follows: prospective cohort study.

Participants Children with severe sepsis or septic shock who were admitted to the intensive care unit of a university pediatric hospital.

Intervention Vital signs, sepsis assessment, pediatric sequential organ failure assessment (PSOFA) score, high-density lipoprotein (HDL), Apo A-5, TG, low-density lipoprotein (LDL), TC, D-dimer, mortality outcome, and pediatric risk of mortality (PRISM) III score were evaluated.

Outcomes The primary outcome was in-hospital nonsurvival.

Results The nonsurvivors had significantly higher D-dimer levels than the survivors, with a significant cutoff level of 0.87 μg/mL (AUC: 0.85, sensitivity: 93.3%, PVN: 90.6%, accuracy: 79.0%, PVP: 72.5%, and specificity: 64.7%). D-dimer was inversely correlated with WBC count and positively correlated with patient age, PRISM III score, PSOFA score, and INR. However, nonsurvivors had higher TG levels and lower TC, HDL, LDL, and Apo A-5 levels than survivors, but this variation was insignificant. Apo A-5 levels were inversely correlated with HDL and positively correlated with TG levels.

Conclusions This study suggests that D-dimer is a promising biomarker for severe sepsis in children, with a mortality cutoff level of 0.87 μg/mL. However, lipid profiles are not predictors of sepsis-related mortality.

Keywords D-dimer, Lipid, Mortality, Prognosis, Septic shock, Severe sepsis

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Background

In critical care settings, patients experience energy deficits and significant metabolic changes during their initial hospitalization in the pediatric intensive care unit (PICU). Septicemia can result in an abnormal immunological response, causing tissue damage and organ failure. Why some patients react severely to similar illnesses like sepsis while others do not is still a mystery [1–3].

One of the key features of sepsis is a disturbance in physiologically localized coagulation activity, which is a component of disseminated intravascular coagulation (DIC). Coagulopathy releases varying amounts of D-dimer due to concurrent coagulation activation and inhibition of natural anticoagulants and fibrinolysis. D dimer reflects the complex nature of the inappropriate body response to septicemia, leading to multisystem failure and higher mortality [4–6]. Therefore, we studied the association between the levels of D-dimer and in-hospital nonsurvival associated with sepsis in children.

Total cholesterol (TC) and lipoproteins are integral components of protection against inflammation or infection. They are responsible for regulating the generation of cytokines during an inflammatory reaction and suppressing the body's response. They are required for the efficient functioning of both the adaptive and innate immune systems during an infection. Furthermore, lipoproteins are essential for the hepatic use of bioactive lipids for physiological defense [7–9].

Sepsis has the potential to induce dyslipidemia, a condition that is closely linked with sepsis-induced mortality. Nevertheless, these findings have only been reported in adult sepsis studies [10–13]. Recent interest has focused on assessing dyslipidemia in patients with sepsis due to reports of abnormal TC and lipoprotein levels in adults suffering from severe acute inflammatory diseases. According to the conclusions of these studies on adult patients, appropriate levels of TC, lipoproteins [low-density lipoprotein (LDL) and high-density lipoprotein (HDL)], apolipoproteins such as apolipoprotein A-V (Apo A-5), and triglycerides (TG) are required to fight infection successfully, but excess or deficient levels are detrimental [10–13].

Based on current knowledge, the impact of dyslipidemia and D-dimer values on children with severe sepsis remains undetermined. Hence, the current research attempted to investigate the relationship between D-dimer values as a coagulation indicator, lipid profile, and in-hospital nonsurvival in pediatric patients with severe sepsis/septic shock.

Methods

Criteria for patient inclusion and exclusion

This prospective cohort study included 60 hospitalized patients exhibiting severe sepsis or septic shock in the PICU of a university tertiary hospital in conjunction with the clinical pathology department. It was executed between May 16, 2022, and April 30, 2023. Upon admission, we assessed the lipid profiles of consecutive patients ranging in age from 28 days to 16 years. Our patients were consecutively selected based on the diagnostic criteria, as outlined in Surviving Sepsis Campaign Worldwide Strategies 2020 [14] and the International Pediatric Sepsis Collaborative Committee (IPSCC 2005) [8]. Three factors were considered to be indicative of severe sepsis: (1) having at least two age-related systemic inflammatory response syndrome (SIRS) criteria (2) having an invasive infection that is confirmed or suspected; and (3) having cardiovascular dysfunction, acute respiratory distress syndrome (ARDS), or at least two non-cardiovascular organ dysfunctions. Septic shock was the term used to describe the subgroup of patients with cardiovascular dysfunction, which included hypotension, vasopressor treatment, or impaired perfusion. We excluded patients with known dyslipidemia, severe malnutrition, or end-stage disease (liver, renal, etc.). Patients receiving lipid containing parenteral nutrition upon admission or those recently receiving chemotherapy or steroid treatment were excluded.

Data collection

Data on patient age, sex, vital signs, sepsis assessment, including 24-h pediatric sequential organ failure assessment (PSOFA) [15, 16], and pediatric risk of mortality (PRISM) III [16, 17] were evaluated. Respiratory and circulatory care, feeding, drugs, transfusions, and surgical procedures were recorded on a daily basis. The outcome of interest was in-hospital nonsurvival, and our patients were divided into survivor and nonsurvivor groups. Using a Sysmex automatic cell counter (model XN 330), full blood counts were carried out. The coagulation process profile was assessed using a Sysmex automated blood-coagulation analysis tool, model CS 2100. On the Roche Cobas 8000 auto analyzer, c702 module, using spectrophotometry, tests for liver and kidney function, calcium, magnesium, and phosphorus levels were performed (Roche Diagnostics, Switzerland). C-reactive protein (CRP) was tested using the immunoturbidimetric technique on a Roche Cobas 8000 autoanalyzer, c702 module. Procalcitonin was measured by electrochemiluminescence on a Roche Cobas 8000 autoanalyzer using the e 602 module. We assessed the levels of TC, lipoproteins (LDL and HDL), Apo A-5, D-dimer, and TG.

Determination of lipid profile and D-dimer levels

A blood sample was taken from each patient upon admission. The lipid levels were measured according to the manufacturer's recommendations. We tested LDL, HDL, TC, and TG levels using a Roche Cobas 8000 autoanalyzer, c702 module, by spectrophotometry. The APO-5 test blood sample was collected and separated in a plain sample vacutainer tube. The sample was centrifuged at 3000 rpm for 20 min after being left at room temperature, and the resultant serum was kept at − 20 °C. Shanghai Sunred Biological Technology Co., Ltd., China, provided the test kit (catalogue no. 201–12-5981). In accordance with the producer's recommendations, we determined apolipoprotein A-V levels using a standard curve after an enzyme-linked immunosorbent assay (ELISA). The kit applies a double-antibody sandwich ELISA to analyze the value of serum APO-5 in each specimen. D-dimer was tested in patients' citrated plasma using the immunoturbidimetric technique on a Roche Cobas 8000 autoanalyzer, c702 module, utilizing the manufacturer's dedicated reagents.

Statistical analysis

To manage the present study's data, SPSS version 23 was used. The mean plus standard deviation (SD) was employed for quantitative variables, but for qualitative variables, numbers and percentages were employed. Student's "*t*" test compares the means of two distinct groups. Mann–Whitney test determined the difference between quantitative variables in two data groups that were not regularly distributed. To determine the relationship between the two groups, we used the chi-square test (χ^2). If one cell is less than 5, the Fisher exact test is performed instead of the chi-square test. A test for the correlation coefficient was used to compare several variables in a linear correlation that was either positive or negative. The ROC curve for the prognostic performance of TC, Apo A-5, lipoproteins, TG, and D-dimer in detecting PICU mortality associated with sepsis. The results that are significant have a probability value of ≤ 0.05. The value of probability > 0.05 denotes insignificant findings.

Results

The current study included 60 patients (38 had septic shock and 22 had severe sepsis), and thirty patients (50%) died. Age, baseline respiratory rate, PRISM III score, international normalized ratio (INR), PSOFA score, CRP, and mechanical ventilation requirements of the nonsurvivors were significantly higher than those of the survivors, as shown in Table 1.

Nonsurvivors had higher TG levels and lower TC, HDL, LDL, and APO-5 levels than survivors, but this variation was insignificant. Additionally, they had significantly higher D-dimer levels than survivors, as demonstrated in Table 2.

The predictive performance of lipid profile and D-dimer for PICU mortality due to sepsis is shown in Table 3. Only D-dimer was shown to have a significant result, and the threshold (cutoff) level of D-dimer was 0.87 μg/mL (area under the curve (AUC): 0.85, sensitivity: 93.3%, predictive value negative (PVN): 90.6%, accuracy: 79.0%, predictive value positive (PVP): 72.5%, and specificity: 64.7%). However, lipid profile levels were not a significant prognostic factor for PICU mortality due to sepsis (Table 3).

D-dimer levels were inversely correlated with white blood cell (WBC) counts and positively correlated with patient age, PRISM III score, PSOFA score, and INR. APO A-5 levels were inversely correlated with HDL and positively correlated with TG, as shown in Table 4.

The ROC curve for the prognostic performance of APO A-5 and D-dimer for detecting sepsis-related in-hospital nonsurvival is shown in Fig. 1.

The ROC curve for the prognostic performance of lipid profile and procalcitonin for detecting sepsis-related in-hospital nonsurvival is shown in Fig. 2.

Discussion

In this unique study, our objectives were to identify the influence of lipid profile values and D-dimer levels, a coagulation indicator, on the prognosis of children with severe sepsis/septic shock. Significant variations in cholesterol and lipoprotein levels have been noticed during systemic inflammatory response conditions in adults [10–13, 18–22]. We concluded that nonsurvivors had significantly higher D-dimer levels than survivors and that D-dimer was inversely correlated with leucocyte count and positively correlated with patient age, PRISM III score, PSOFA score, and INR. The mortality cutoff value of D-dimer was 0.87 μg/mL (AUC: 0.85, sensitivity: 93.3%, PVN: 90.6%, accuracy: 79.0%, PVP: 72.5%, and specificity: 64.7%), indicating that D-dimer is a promising biomarker of severe sepsis. However, nonsurvivors of sepsis had higher TG levels and lower TC, HDL, LDL, and Apo A-5 levels than survivors, but this variation was insignificant. Lipid profile values are not reliable predictors of sepsis-related mortality.

Our findings are consistent with the study by Bermudes et al. [3], in which they found no significant differences in lipid profile alterations between sepsis survivors and nonsurvivors on the first day of PICU admission. Similarly, Maile and colleagues [23] failed to establish a significant correlation between HDL and mortality in adult patients. In addition, no significant difference in the levels of TG was observed between

Table 1 Descriptive data of the studied group

Variables	The studied group No = 60 *Mean ± SD* Median (range)	Survivors No = 30 (50%)	Nonsurvivors No = 30 (50%)	Test	*P* value
Age (months)	46 ± 55.6 12 (1.6–168)	32.8 ± 40.6 12.0 (2–132)	59.9 ± 65.3 14.5 (1.6–168)	M.W 6.5	**0.04***
Sex (*N* and %) Female Male	32 (53.3%) 28 (46.7%)	17 (53.1%) 13 (46.4%)	15 (49.9%) 15 (53.6%)	χ^2 0.2	0.6
HR (per minute)	128.9 ± 21.9 130 (81–172)	124.77 ± 22.14 125 (87–166)	132.97 ± 21.35 130 (81–172)	*t* = 1.4	0.1
RR per minute	28.9 ± 15.8 24 (16–91)	23.5 ± 3.1 24 (20–33)	35.1 ± 21.6 25 (16–91)	M.W 2.2	**0.03***
DBP (mmHg)	66.7 ± 14.9 66 (35–97)	69.3 ± 14.6 73.5 (40–94)	64.1 ± 14.6 64 (35–97)	*t* = 1.4	0.1
SBP (mmHg)	107.2 ± 20.1 104.5 (68–151)	110.3 ± 19.9 110 (68–149)	104.2 ± 20.2 103.5 (68–151)	*t* = 1.2	0.2
Sepsis severity					
Severe sepsis Septic shock	22 38	9 (40.9%) 21 (55.3%)	13 (59.1%) 17 (44.7%)	1.1	0.3
Mechanical ventilation					
Yes No	42 18	12 (28.6%) 18 (100%)	30 (71.4%) 0 (0%)	*25.714*	**0.000****
PICU stay (days)	13.3 ± 7.2 13.0 (2–30)	13.4 ± 6.5 14 (3–30)	13.2 ± 8.1 12 (2–30)	M.W 0.07	0.9
PRISM III score (0–74/23)	17.2 ± 6.4 17 (6–36)	14.6 ± 5.04 15.5 (6–25)	19.8 ± 6.6 20 (7–36)	M.W 3.4	**0.001****
PSOFA score (0–24)	8.1 ± 3.07 8 (2–16)	6.8 ± 2.6 6 (2–12)	9.37 ± 3.06 9 (4–16)	M.W 3.5	**0.001****
Total WBCs (10^9/L)	14.5 ± 7.8 12.7 (3.4–38.5)	13.6 ± 7.17 13.4 (3.4–29.0)	15.3 ± 8.4 12.7 (6.4–38.5)	M.W 0.8	0.4
Procalcitonin (**ng/ml**)	17.8 ± 30.7 3.2 (0.2–100)	12.5 ± 23.3 2.5 (0.02–100)	23.2 ± 36.2 4.7 (0.03–100)	M.W 1.3	0.17
CRP (mg/L)	63.7 ± 80.2 24.7 (0.06–336.1)	38.8 ± 47.5 11.9 (0.06–142.2)	88.5 ± 97.7 57.2 (0.66–336.1)	M.W 2.5	**0.01***
INR	1.2 ± 0.42 1.13 (0.1–2.38)	1.07 ± 0.23 1.1 (0.1–1.42)	1.35 ± 0.52 1.15 (0.45–2.38)	M.W 2.6	**0.01***

CRP C-reactive protein, *DPB* Diastolic blood pressure, *HR* Heart rate, *INR* International normalized ratio, *MW* Mann–Whitney, *PICU* Pediatric intensive care unit, *PRISM* Pediatric risk of mortality, *PSOFA* Pediatric sequential organ failure assessment, *RR* Respiratory rate, *SBP* Systolic blood pressure, *t* Student's "*t*" test, *WBC* White blood cells

χ^2, chi-square test

* Statistically sensitive

** Statistically highly sensitive

patients with sepsis, whether they survived or not, and healthy controls, according to Sharma et al. [24]. In contrast, Barlage et al. [10] observed that the lipid profile was significantly lower in nonsurvivors and predicted sepsis-associated fatality. According to Lee et al. [13], TC and CRP are inversely related, and lower TG levels are associated with sepsis mortality. Yildiz et al. [25] also observed reduced total cholesterol and lipoproteins, especially HDL, in neonates with sepsis compared with the control group and found an inverse

Table 2 Lipid profile and D-dimer of the studied group

Variables	The studied group No = 60 *Mean ± SD* Median (Range)	Survivors No = 30 (50%)	Nonsurvivors No = 30 (50%)	Test	*P* value
Cholesterol (mg/dl)	120.1 ± 21.9 119.5 (76–161)	124.6 ± 22.3 124.5 (78–161)	115.5 ± 20.9 113.9 (76–157)	*t* = 1.6	0.1
Triglycerides (mg/dl)	135.6 ± 46.7 125 (67–282.7)	124.7 ± 22.1 125 (87–166)	136.5 ± 47.7 126.3 (67–182.7)	*t* = 0.1	0.8
HDL (mg/dl)	38.5 ± 10.9 40.8 (10.2–55)	38.7 ± 11.2 42.4 (10.6–52)	38.3 ± 10.7 38.3 (10.2–55)	*t* = 0.1	0.9
LDL (mg/dl)	53.2 ± 22.1 54.8 (9.3–95)	55.1 ± 22.4 56.6 (13.5–92)	51.4 ± 21.9 51.6 (9.3–95)	M.W 0.6	0.5
Apo A-5 (ng/ml)	601.5 ± 657.1 364.6 (42.1–2890.6)	699.1 ± 772.9 417.5 (62.7–2890.6)	504.1 ± 511.4 328.6 (42.1–2568.7)	M.W 1.1	0.2
D-dimer (< 0.4 μg/mL)	2.55 ± 2.69 1.21 (0.27–9.7)	1.24 ± 1.25 0.83 (0.27–5.61)	3.85 ± 3.1 2.6 (0.75–9.7)	M.W 4.3	**0.001****

Apo A-5 Apolipoprotein A-V, *HDL* High-density lipoprotein, *LDL* Low-density lipoprotein, *MW* Mann–Whitney, *t* Student's "*t*" test

** Statistically highly sensitive

Table 3 The predictive performance of lipid profile and D-dimer for PICU mortality due to sepsis

Variables	Cholesterol (mg/dl)	Triglycerides (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	Apo A-V (ng/ml)	D-dimer (μg/mL)
Cut off point	*109.2*	112.5	43.3	47.4	*89.5*	0.87
AUC	0.62	0.49	0.55	0.54	0.56	0.85
Significance	0.1	0.9	0.5	0.5	0.4	**0.001****
95% CI	(0.48–0.76)	(0.34–0.64)	(0.39–0.71)	(0.39–0.69)	(0.41–0.7)	(0.75–0.94)
Sensitivity	73.1%	70.0%	70.0%	63.3%	73.4%	93.3%
Specificity	40%	30.0%	47.0%	44.0%	32.1%	64.7%
PVP	54.9%	50.0%	56.9%	53.1%	51.9%	72.5%
PVN	59.7%	50.0%	61.1%	54.5%	54.7%	90.6%
Accuracy	56.5%	50.0%	58.5%	63.5%	52.7%	79.0%

Apo A-5 Apolipoprotein A-V, *AUC* Area under the curve, *CI* Confidence interval, *HDL* High-density lipoprotein, *LDL* Low-density lipoprotein, *PVN* Predictive value negative, *PVP* Predictive value positive

** Statistically highly sensitive

relationship between inflammatory markers and HDL and TC levels. According to Wang et al. [26], serum Apo A-5 levels were significantly reduced in nonsurvivors and had predictive value for sepsis-associated multiorgan dysfunction in children. Ngaosuwan et al. [27] reported that children with sepsis had considerably greater absolute values of serum Apo A-5 than adult patients with sepsis and that Apo A-5 levels were significantly reduced in those who did not survive and were correlated with septic shock.

Our research revealed insignificant results regarding the reliability of the lipid profile in predicting death in children with severe sepsis. This might be explained by the characteristics of our study's participants: presenting with severe sepsis, high PRISM III and PSOFA scores, and a mortality rate of 50%. The lipoproteins are vital throughout the infection recovery period. The relationship between lipoproteins and mortality is due to previous comorbid medical conditions or an indicator of disease progression [23].

Table 4 Correlation between apo-lipoprotein A-V and D-dimer with patient characteristics among the studied group

Variables	Apo A-5			D-dimer		
	r	*P* value	Significance	*r*	*P* value	Significance
Age	0.005	0.9	NS	0.28	**0.03***	**S**
HR	0.07	0.5	NS	0.08	0.6	NS
RR	0.1	0.5	NS	0.5	0.6	NS
DBP	0.1	0.3	NS	0.08	0.6	NS
SBP	0.07	0.6	NS	0.07	0.5	NS
Total WBCs	0.1	0.2	NS	−0.3	**0.03***	**S**
CRP	0.03	0.8	NS	0.2	0.1	NS
INR	0.2	0.1	NS	0.52	**0.001****	**HS**
PICU stay	0.2	0.1	NS	0.23	0.07	NS
PRISM III	0.11	0.3	NS	0.5	**0.001****	**HS**
Procalcitonin	0.002	0.9	NS	0.07	0.6	NS
PSOFA	0.04	0.7	NS	0.4	**0.001****	**HS**
D-dimer	0.1	0.3	NS	––––-	––––-	––––-
Apo A-5	––––-	–––	––––-	0.1	0.3	NS
Cholesterol	−0.2	0.1	NS	−0.1	0.4	NS
Triglycerides	0.4	**0.001****	**HS**	−0.04	0.7	NS
HDL	−0.4	**0.002***	**S**	0.09	0.5	NS
LDL	−0.1	0.2	NS	−0.2	0.1	NS

Apo A-5 Apolipoprotein A-V, *CRP* C-reactive protein, *DPB* Diastolic blood pressure, *HDL* high-density lipoprotein, *HR* Heart rate, *HS* Highly sensitive, *INR* International normalized ratio, *LDL* Low-density lipoprotein, *NS* Nonsensitive, *PICU* Pediatric intensive care unit, *PRISM* Pediatric risk of mortality, *PSOFA* Pediatric sequential organ failure assessment, *RR* Respiratory rate, *S* Sensitive, *SBP* Systolic blood pressure, *WBC* White blood cells

r, correlation coefficient

* Statistically sensitive

** Statistically highly sensitive

Our study indicates that nonsurvivors had significantly higher D-dimer levels than survivors, and a threshold of 0.87 μg/mL was statistically significant as a predictor of mortality from sepsis, with good sensitivity (93.3%) and average specificity (64.7%). D-dimer has been shown to be inversely correlated with leucocyte count and to have a positive correlation with patient age, PRISM III score, PSOFA score, and INR. Our findings are comparable to those of Wang and colleagues [28], who recognized an association between D-dimer and PICU mortality with a threshold value of 1.53, 65% sensitivity, and 77% specificity. Jhang et al. [29] found that children experiencing septic shock had increased D-dimer levels, particularly in those who did not survive.

Although Foaud et al. [30] studied D-dimer levels in pediatric patients treated for trauma rather than sepsis, they found comparable results with the same sensitivity (90%) and higher specificity (100%). The discrepancies in cutoff values and specificity might be attributed to changes in sample size and participant demographics in different studies. Additionally, patients presenting with sepsis with higher D-dimer levels have a higher risk of death [31].

Sepsis can involve various procoagulant and fibrinolytic mechanisms, resulting in significant variation in the blood components of the immune reaction as well as the development of distinct forms of coagulopathies. This disparity affects key factors such as blood coagulation stimulation, suppression of natural anticoagulants, and fibrinolysis suppression. Coagulation indicators can be helpful in identifying the extent and/or form of coagulopathy that develops during sepsis. D-dimer represents a potential marker for identifying the various clinical forms of septicemia. Furthermore, D-dimer could potentially determine which patients would benefit from anti-inflammatory or anticoagulant treatments [5, 6, 32, 33].

D-dimer values are correlated with inflammatory biomarkers, including interleukins 6 and 8. The onset of DIC, particularly in sepsis, involves activation of the coagulation process and fibrin degradation. Such undesired events can dramatically increase the likelihood of multisystem organ failure and death [29, 34]. Patients with normal D-dimer levels had a lower mortality risk than those with abnormal levels, according to Lyngholm et al. [35].

Conversely, Semeraro et al. [36, 37] found that a correlation exists between reduced levels of D-dimer and

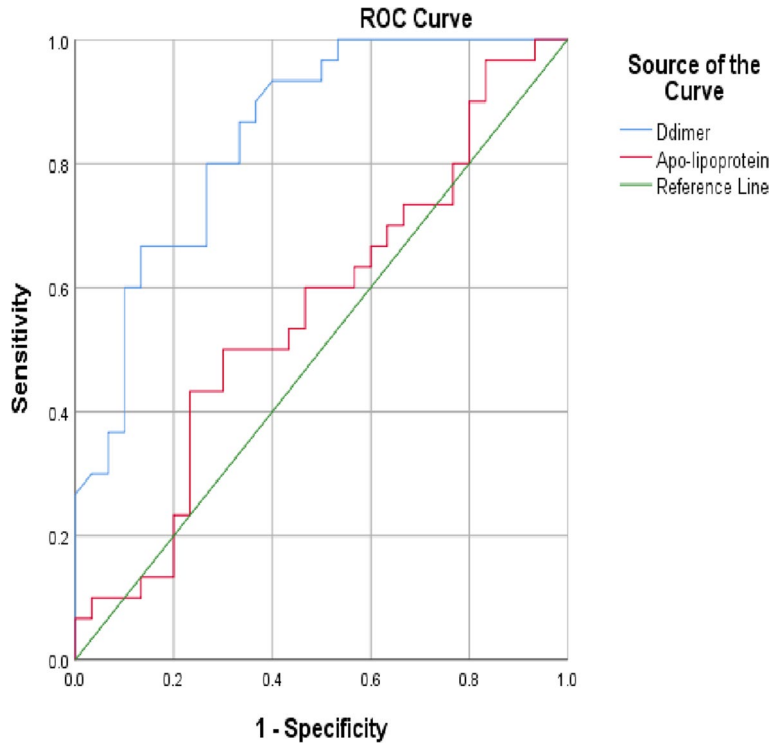

Fig. 1 ROC curve for the prognostic performance of apo-lipoprotein A-V and D-dimer to detect PICU mortality due to sepsis

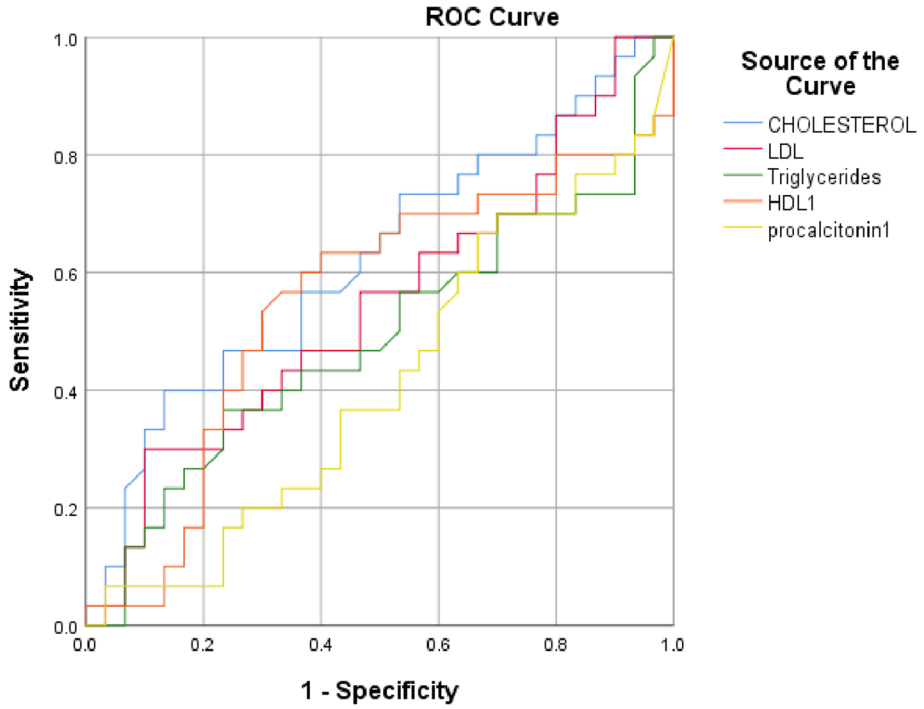

Fig. 2 ROC curve for the prognostic performance of lipid profile and procalcitonin to detect PICU mortality due to sepsis

decreased survival rates in patients with sepsis. These contradictory results should not be viewed as evidence that D-dimer is an unreliable marker of sepsis severity. Instead, they reflect its uniqueness in the context of different illnesses and infections.

The current study's limitations included a relatively small number of participants, which precluded the demonstration of significant differences in lipid profile alterations. Additionally, the lack of a control group represents another limitation. Finally, since our study was conducted in a single tertiary center, the general applicability of the results may be limited by patient characteristics, financial resources, healthcare legislation, and staff quality.

The lessons learned from this research are that D-dimer fulfills the desired standards for a sepsis prognostic marker. D-dimer level is a good predictor of sepsis-related death. Regarding the lipid profile, nonsurvivors exhibit higher TG and lower TC, HDL, LDL, and Apo A-5 levels than survivors, but this disparity is statistically insignificant. Therefore, it is not advisable to rely on lipid profile values as predictors of sepsis-related mortality.

To our knowledge, the present research is one of the few published studies to date pertaining to the early assessment of lipid profiles and coagulation biomarkers (D-dimer) in patients with sepsis in this age group. The results of this study are pragmatic for clinical purposes and provide a foundation for future multicenter studies worldwide to further evaluate D-dimer and lipid profiles in pediatric patients with sepsis.

Conclusions

The current investigation suggests that D-dimer levels of nonsurvivors of severe sepsis are higher than those of survivors, with a mortality cutoff of 0.87 μg/mL (AUC: 0.85, sensitivity: 93.3%, and specificity: 64.7%), thereby establishing D-dimer as a promising biomarker for severe sepsis in children. Moreover, D-dimer levels were inversely correlated with the leucocyte count and positively correlated with patient age, PRISM III score, PSOFA score, and INR. However, it is worth noting that nonsurvivors exhibit higher TG and lower TC, HDL, LDL, and Apo A-5 levels than survivors, but this disparity is statistically insignificant. The lipid profiles are not predictors of sepsis-related mortality.

Abbreviations

Apo A-5	Apo lipoprotein A-V
ARDS	Acute respiratory distress syndrome
AUC	Area under the curve
CRP	C-reactive protein
DIC	Disseminated intravascular coagulation
ELISA	Enzyme-linked immunosorbent assay
HDL	High-density lipoprotein
INR	International normalized ratio
IPSCC	International Pediatric Sepsis Collaborative Committee
LDL	Low-density lipoprotein
PICU	Pediatric intensive care unit
PRISM	Pediatric risk of mortality
PSOFA	Pediatric sequential organ failure assessment
PVN	Predictive value negative
PVP	Predictive value positive
SIRS	Systemic inflammatory response syndrome
TC	Total cholesterol (TC)
TG	Triglycerides
WBC	White blood cells

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Authors' contributions

MAA, TAA, WII, EGB, and IAI conceived the study, participated in the study's design, assisted in data collection, and participated in checking, analyzing and interpreting the data and drafting the manuscript. WII did the laboratory investigations and analyzed the results and interpreted the revealed data. MAA, TAA, IAI, and EGB analyzed and interpreted the laboratory measurements. All authors have read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by Zagazig University Institutional Review Board (ZU-IRB # 9464/15–5-2022). The IRB approved that it is within the ethical guidelines as outline in the Declaration of Helsinki. The patients' parents provided written informed consent to participate in this study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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