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Original Article

Lipid Profile as a Predictive Marker for Organ Dysfunction after Thoracoabdominal Surgery: A Cross-sectional Study

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What's Known

- Given the complexity of lipid metabolism in critically ill patients, despite its substantial association with major clinical outcomes, as far as we know, a limited number of studies investigated the association of lipid profiles with multiple organ dysfunction.

What's New

- According to the results of our investigation, low serum TC levels could be considered a risk factor for mortality, organ dysfunction, and clinical outcomes. On the other hand, in patients undergoing thoracoabdominal surgery, LDL, HDL, and TG indicated protective roles in terms of mortality, organ dysfunction, and clinical outcomes.

Abstract

Background: Plasma total cholesterol is considered a negative acute phase reactant. In various pathological conditions, such as trauma, sepsis, burns, and liver dysfunction, as well as post-surgery, serum cholesterol level decreases. This study aimed to investigate the role of lipid profiles in determining the probability of organ dysfunction after surgery.

Methods: This cross-sectional study included patients who underwent thoracoabdominal surgery and were admitted to the intensive care unit of Imam Reza Hospital in Tabriz, Iran, between October 2016 and September 2018. During the first two days of admission, blood samples were taken, and serum levels of total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), Low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), and albumin were measured. The relation between the changes in these laboratory markers and six organ functions including cardiovascular, respiratory, renal, central nervous system, hepatic, and hematologic, length of stay in the hospital and intensive care unit, mechanical ventilation duration, and vasopressor use were investigated. The independent *t* test was used to compare continuous variables. The association between different variables and organ dysfunction and mortality was evaluated by using logistic regression.

Results: The serum TC increased the risk of mortality (OR=1.09, 95%CI=1.06-1.11, P<0.001), renal dysfunction (OR=1.09, 95%CI=1.06-1.12; P<0.001), liver dysfunction (OR=1.07, 95%CI=1.03-1.10; P<0.001), respiratory dysfunction (OR=1.08, 95%CI=1.05-1.13; P<0.001). Moreover, LDL, HDL, and TG were found to be inversely related to mortality, organ dysfunction, length of stay in the hospital and intensive care unit, mechanical ventilation duration, and vasopressor use.

Conclusion: TC could be considered a risk factor for mortality, organ dysfunction, and clinical outcomes. On the other hand, LDL, HDL, and TG played a protective role in the patients' mortality, organ dysfunction, and clinical outcomes.

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Keywords ● Multiple organ failure ● Cholesterol ● Intensive care units ● Mortality

Introduction

Multiple organ dysfunction syndrome (MODS) refers to the occurrence of potentially reversible physiologic derangement in more than one organ as a result of trauma, infection, burn, aspiration, pulmonary contusion, multiple blood transfusions, and pancreatitis.[1] MODS has remained the leading cause of mortality and prolonged hospitalization in the intensive care unit (ICU).[2] Three new organ dysfunction scores, including the Sequential (formerly, Sepsis-related) Organ Failure Assessment (SOFA) score, APACHE (Acute Physiology and Chronic Health Evaluation) score, and the Logistic Organ Dysfunction (LOD) score, were introduced for use in critically ill patients.[2] Severe illness has been proven to affect plasma lipid levels. Diet and nutritional factors influence high-density lipoprotein cholesterol (HDL-C) and total cholesterol (TC). The TC level is one of the several blood tests that are regularly performed upon admission and is an independent predictor of future mortality from all causes.[3] Screening TC and HDL-C in patients undergoing general surgery can help determine the risk of cardiovascular and respiratory tract infections.[4] Organ dysfunction scores are routinely utilized to describe ICU patient populations. MODS is generally known as the most common cause of death in surgical ICUs, and there is a direct relationship between the number of organ failures, ICU mortality, and length of hospitalization.[5] Hypocholesterolemia is common in critically ill patients and may have prognostic value.[6] Despite the fact that hypocholesterolemia is considered a marker of malnutrition, it is frequently used as a marker of disease severity following surgery and trauma, sepsis, as well as other critical conditions.[7] A relationship were found between hypocholesterolemia and a number of disorders, as well as organ dysfunction. Moreover, it is possible to predict mortality in patients with multiple organ dysfunction using TC and HDL-C.[8] In patients with severe sepsis, lipid profile can be used as an early independent predictor of poor outcome and mortality.[9] Moreover, in critically ill patients with systemic inflammatory response syndrome, lower cholesterol levels were associated with mortality.[10] In recent years, researchers have also studied this relationship. In patients with cardiogenic shock, increased concentration of LDL-C was associated with a reduced risk of in-hospital and 28-day mortality and improved survival.[11] In septic patients admitted to ICU, low HDL-C and LDL-C values were significantly associated with 28-day mortality.[12] Even in critically ill patients with pneumonia, diffuse peritonitis, and patients with acute pancreatitis, an association between lipid profile, outcomes and mortality were reported.[13-15] Furthermore, HDL enhances arterial health, inhibits LDL-C aggregation, and has antioxidant, antithrombotic, and anti-apoptotic properties.[16] HDL-C were significantly decreased in patients who experienced MODS or died.[17] The levels of HDL-C in patients with suspected sepsis may provide valuable and easily accessible prognostic information for clinicians and enable them to perform more immediate intervention for those who are at the highest risk for progression to multiple organ dysfunction.[17] This study investigated the association between lipid profile and the development of organ dysfunction and mortality in critically ill surgical patients admitted to ICU.

Patients and Methods

Study Population

This cross-sectional study was conducted on 498 patients admitted to the general ICU of Imam Reza Hospital, (Tabriz, Iran). The convenient sampling method was used, and the study population was recruited from patients scheduled for thoracoabdominal surgery between October 2016 and September 2018. This study was approved by the Ethics Committee of Tabriz University of Medical Sciences, Tabriz, Iran (IR.TBZMED.REC.1396.840). Written informed consent was obtained from all patients before the surgery. Exclusion criteria included being under the age of 18, undergoing urgent surgery, having a history of hyperlipidemia, and taking lipid-lowering medications. Age, sex, BMI, smoking, alcohol consumption, diabetes mellitus, chronic disorders, and malignant diseases were all taken into account prior to surgery. Moreover, the length of stay in the hospital and ICU, duration of mechanical ventilation, and mortality rate were all recorded. Each of the aforementioned variables was noted in a questionnaire.

Laboratory Tests

Blood samples were collected within 24 hours of ICU admission on the first day and the morning of the second day for patients scheduled for surgery. The results of clinical chemistry tests were collected. Following an overnight 12-hour fast, all routine laboratory tests were performed on the third day of hospitalization. Serum albumin, TC, HDL-C, LDL-C, and TG concentrations were measured using standardized enzymatic methods (Roche Diagnostic Systems, Indianapolis, IN) and a biochemical analyzer (Beckman Coulter, Brea, CA, USA) in the central laboratory of the hospital. The organ dysfunction score (SOFA),[18] and mortality rate were recorded for all patients.

Statistical Analysis

All the data were analyzed using the SPSS software, version 20 (IBM Statistics, Chicago, USA). Data were expressed as mean±SD, or numbers and percentages. Continuous variables were analyzed using an independent *t* test. Logistic regression was used to evaluate the associations between TC, TG, HDL-C, LDL-C, albumin, multi-organ dysfunction as well as the mortality rate. The Linear regression models were used to investigate the effects of different levels of TC, TG, HDL-C, LDL-C, and albumin on the length of hospitalization in the hospital and ICU. P<0.05 was considered statistically significant.

Results

This study included 244 men and 254 women. A total of 51 deaths occurred during hospitalization. The demographic characteristics of the patients are presented in table 1. The associations of in-hospital mortality and organ dysfunction with lipid profile and albumin are presented in table 2.

Table 1: Demographic characteristics of patients

Variables		Patients (n=498)
Age		68.11±29.36
Sex	Male	244 (48.96%)
	Female	254(51.04%)
Smoking		142 (28.5%)
Alcohol		38 (7.6%)
SOFA Score		10.46±3.20
Post-operation organ dysfunction	Renal	82 (16.4%)
	Hepatic	16 (3.2%)
	CNS	6 (1.2%)
	Respiratory	88 (17.6%)
	Cardiovascular	87 (17.4%)
	Coagulation	24 (4.8%)
ICU length of stay		4.1±1.7
Hospital length of stay		5.2±1.4
Mechanical ventilation duration		1.5±0.6
Vasopressor usage duration		1.2±0.5
Mortality		51 (10.2%)

SOFA score: Sequential organ failure assessment; CNS: Central nervous system

Table 2: Relationship of lipid level with organ dysfunctions and mortality

	TC (mg/dL) (mean±SD)	HDL-C (mg/dL) (mean±SD)	LDL-C (mg/dL) (mean±SD)	TG (mg/dL) (mean±SD)	Alb (g/dL) (mean±SD)
Survived(448)	228.61±23.75	45.66±8.60	168.08±19.77	166.45±34.00	2.69±1.04
Dead (51)	199.46±16.59	43.22±7.08	148.91±74.07	160.52±21.88	3.28±0.75
P value	<0.001	0.05	0.06	0.22	<0.001
Without renal dysfunction	217.78±20.44	45.30±8.71	153.89±16.98	161.90±28.20	3.03±0.75
With renal dysfunction	199.43±17.89	45.99±7.25	150.27±76.97	160.98±22.41	3.26±0.81
P value	<0.001	0.50	0.67	0.78	0.01
Without liver dysfunction	230.81±21.54	45.31±8.48	163.56±21.91	171.12±39.68	3.10±0.34
With liver dysfunction	201.50±18.77	48.31±8.50	150.45±71.72	160.80±22.69	3.23±0.82
P value	<0.001	0.16	0.46	0.31	0.54
Without CNS dysfunction	217.50±21.65	45.34±8.49	149.67±16.53	169.66±26.42	2.98±0.24
With CNS dysfunction	202.26±19.46	50.83±6.17	150.88±71.10	161.02±23.41	3.22±0.81
P value	0.05	0.11	0.96	0.37	0.46
Without Resp dysfunction	213.95±27.12	45.05±7.05	152.77±14.18	161.21±29.94	2.90±1.02
With Resp dysfunction	199.98±16.53	47.11±13.19	150.46±77.63	161.11±21.86	3.29±0.74
P value	<0.001	0.03	0.78	0.97	<0.001
Without CV dysfunction	215.76±20.32	45.29±8.74	153.13±15.42	157.96±24.78	3.06±0.89
With CV dysfunction	199.63±18.19	45.97±7.18	150.39±77.49	161.79±23.12	3.25±0.78
P value	<0.001	0.50	0.74	0.16	0.04
Without coagulopathy	230.54±21.53	45.41±8.56	164.88±20.85	164.88±20.85	2.93±0.95
With coagulopathy	201.03±18.37	45.13±6.88	150.19±72.32	160.63±23.10	3.24±0.80
P value	<0.001	0.87	0.32	0.02	0.07

TC: Total cholesterol; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; TG: Triglyceride; Alb: Albumin; CNS: Central nervous system; Resp: Respiratory; CV: Cardiovascular; Independent *t* test was used. P<0.05 was considered statistically significant

There was a significant difference in levels of TC (P<0.001) and albumin (P=0.001) between the survivors and non-survivors groups.

As shown in table 3, age (OR=1.02, CI=1.00-1.05, P=0.04), TC (OR=1.09, CI=1.06-1.11, P<0.001), HDL-C (OR=0.90, CI=0.85-0.95, P<0.001), and albumin (OR=0.61, CI=0.43-0.86, P=0.005) were identified as predictor factors for mortality. Among all studied variables, TC, HDL-C, and LDL-C levels had significant effects on renal dysfunction. Only TC level had a significant effect on liver dysfunction. Age was the only variable that had a significant effect on central nervous system (CNS) dysfunction.

Table 3: The association between lipid profile, albumin with mortality, and multiple organ dysfunction syndrome

	Age	Sex	TC (mg/dL)	HDL-C (mg/dL)	LDL-C (mg/dL)	TG (mg/dL)	Alb (g/dL)
Mortality							
Crude OR (95% CI)	1.02 (1.00-1.05)	0.69 (0.32-1.47)	1.09 (1.06-1.11)	0.90 (0.85-0.95)	1 (0.99-1.00)	0.99 (0.97-1.00)	0.61 (0.43-0.86)
P value	0.04	0.34	<0.001	<0.001	0.97	0.36	0.005
Adjusted model OR (95% CI)*	-	-	1.07 (1.056-1.09)	0.95 (0.91-0.99)	1.00 (0.99-1.00)	1.00 (0.99-1.02)	0.55 (0.43-0.72)
P value*	-	-	<0.001	0.01	0.21	0.13	<0.001
Renal dysfunction							
Crude OR (95% CI)	0.98 (0.93-1.03)	0.91 (0.53-1.58)	1.09 (1.06-1.12)	0.93 (0.89-0.98)	0.93 (0.90-0.96)	0.99 (0.98-1.00)	0.93 (0.68-1.27)
P value	0.48	0.75	<0001	0.01	<0.001	0.16	0.67
Adjusted model OR (95%CI)*	-	-	1.00 (0.98-1.01)	1.01 (0.98-1.05)	1.00 (0.99-1.00)	1.00 (0.98-1.01)	0.74 (0.58-0.95)
P value*	-	-	0.99	0.35	0.79	0.99	0.02
Liver dysfunction							
Crude OR (95% CI)	0.93 (0.85-1.03)	0.54 (0.16-1.80)	1.07 (1.03-1.10)	1.03 (0.95-1.12)	0.99 (0.97-1.02)	1 (0.98-1.02)	1.03 (0.49-2.17)
P value	0.20	0.32	<0.001	0.35	0.93	0.52	0.92
Adjusted model OR (95% CI)*	-	-	1.06 (1.04-1.09)	1.06 (0.98-1.15)	1.00 (0.99-1.00)	1.01 (0.99-1.03)	0.84 (0.49-1.43)
P value*	-	-	<0.001	0.11	0.56	0.06	0.52
CNS dysfunction							
Crude OR (95% CI)	0.85 (0.73-0.99)	0.00 (0.00-0.00)	1.06 (0.97-1.16)	1.10 (0.89-1.35)	0.96 (0.85-1.07)	1.02 (0.98-1.06)	0.50 (0.18-1.43)
P value	0.03	0.99	0.18	0.36	0.49	0.26	0.20
Adjusted model OR (95% CI)*	-	-	1.01 (0.98-1.05)	1.12 (0.96-1.29)	1.00 (0.98-1.01)	1.01 (0.98-1.05)	0.63 (0.28-1.44)
P value*	-	-	0.30	0.12	0.95	0.3	0.28
Respiratory dysfunction							
Crude OR (95% CI)	1.03 (1.00-1.06)	0.82 (0.48-1.40)	1.08 (1.05-1.11)	0.95 (0.90-0.99)	0.94 (0.91-0.97)	0.99 (0.98-1.00)	0.74 (0.56-0.98)
P value	0.01	0.48	<0.001	0.03	<0.001	0.58	0.04
Adjusted model OR (95% CI)*	-	-	1.00 (0.99-1.01)	1.01 (0.98-1.05)	1.00 (0.99-1.00)	1.00 (0.99-1.01)	0.65 (0.51-0.82)
P value*	-	-	0.62	0.38	0.89	0.62	<0.001
CV dysfunction							
Crude OR (95% CI)	1.01 (0.97-1.06)	1.93 (1.12-3.31)	1.08 (1.05-1.11)	0.95 (0.91-1.00)	0.95 (0.92-0.98)	0.98 (0.96-0.99)	0.93 (0.69-1.25)
P value	0.49	0.01	<0.001	0.07	0.004	0.003	0.64
Adjusted model OR (95% CI)*	-	-	0.99 (0.98-1.00)	1.01 (0.98-1.05)	1.00 (0.99-1.00)	0.99 (0.98-1.00)	0.76 (0.60-0.98)
P value*	-	-	0.13	0.26	0.69	0.13	0.03
Coagulopathy							
Crude OR (95% CI)	0.98 (0.90-1.07)	0.97 (0.38-2.49)	1.07 (1.03-1.12)	0.97 (0.90-1.05)	0.99 (0.94-1.04)	1.00 (0.98-1.02)	0.87 (0.54-1.42)
P value	0.71	0.95	<0.001	0.58	0.81	0.57	0.60
Adjusted model OR (95% CI)*	-	-	1.01 (1.00-1.03)	1.00 (0.94-1.06)	1.00 (0.99-1.00)	1.01 (1.00-1.03)	0.73 (0.50-1.05)
P value*	-	-	0.03	0.89	0.43	0.03	0.09

TC: Total cholesterol; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; TG: Triglyceride; Alb: Albumin; CNS: Central nervous system; CV: Cardiovascular; *Adjusted for age and sex logistic regression test was used. P<0.05 was considered statistically significant.

Table 4: Effect of age, sex, lipid profile, and albumin on clinical outcome of patients

	Age	Sex	TC (mg/dL)	HDL-C (mg/dL)	LDL-C (mg/dL)	TG (mg/dL)	Alb (g/dL)
ICU length of stay							
β	0.04	0.004	0.21	-0.06	-0.003	-0.03	-0.99
SE	0.009	0.41	0.01	0.02	0.003	0.009	0.25
P value	<0.001	0.99	<0.001	0.02	0.33	0.001	<0.001
Hospital length of stay							
β	0.04	-0.08	0.22	-0.05	-0/004	-0.03	-1.11
SE	0.01	0.43	0.01	0.03	0.003	0.01	0.27
P value	<0.001	0.83	<0.001	0.08	0.25	<0.001	<0.001
Mechanical ventilation duration							
β	0.04	0.12	0.19	-0.06	-0.002	-0.03	-0.89
SE	0.009	0.40	0.01	0.02	0.003	0.009	0.25
P value	<0.001	0.75	<0.001	0.02	0.45	<0.001	<0.001
Vasopressor use duration							
β	0.02	-0.01	0.12	-0.04	-0.002	-0.02	-0.67
SE	0.006	0.25	0.008	0.01	0.002	0.006	0.15
P value	<0.001	0.95	<0.001	0.01	0.37	0.001	<0.001
SOFA Score							
β	0.04	0.005	0.15	-0.04	-0.003	-0.04	-0.75
SE	0.008	0.41	0.005	0.002	0.002	0.008	0.20
P value	0.03	0.6	0.04	0.06	0.10	0.005	0.02

TC: Total cholesterol; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoprotein cholesterol; TG: Triglyceride; Alb: Albumin; SOFA score: Sequential organ failure assessment; B: Standardized beta; SE: Standard error; Linear regression test was used. P<0.05 was considered statistically significant.

Age, TC, HDL-C, LDL-C, and albumin levels significantly affected respiratory dysfunction. Cardiovascular dysfunction was significantly influenced by sex, TC, LDL-C, and TG levels. TC levels had a significant effect on coagulopathy as well. The effects of age, sex, lipid profile, and albumin on length of stay in ICU and hospital, duration of mechanical ventilation and vasopressor use, and SOFA score are summarized in table 4.

Our findings revealed that age, TC, TG, and albumin levels had significant effects on ICU and hospital length of stay, duration of mechanical ventilation and vasopressor use, and SOFA score. However, sex and LDL-C had no significant effects on these parameters. Moreover, while HDL-C did not affect hospital length of stay, it had a significant effect on the ICU length of stay, duration of mechanical ventilation, vasopressor use, and SOFA score.

Discussion

The present study indicated that in critically ill patients undergoing thoracoabdominal surgeries, decreased level of TC was a strong predictor of mortality. A decrease in TC levels was also significantly associated with organ dysfunction including CNS, respiratory, cardiovascular, renal, liver, and coagulation. Accurate early prediction of organ dysfunction in critically ill patients can help with patient management.[18] According to physicians' estimates, ICU survival rates of 10% or less can accurately predict mortality.[19] Multiple organ failure, which can be characterized by various degrees and concomitant with organ dysfunction, is a significant source of morbidity and mortality in ICU patients.[18] Previous studies found that low levels of serum albumin independently predicted mortality in hospitalized elderly adults.[20] Among hospitalized adults, low serum cholesterol levels seemed to be an independent predictor of short-term intra-hospital mortality.[21] Reduced serum cholesterol were proven to be a predictor of mortality in sepsis patients.[8] Low cholesterol concentrations had a linear correlation with mortality in critically ill patients, suggesting that they could be used as a prognostic indicator in clinical settings. The mortality of these hypocholesterolemic patients was approximately tenfold higher than the average of all hospitalized patients.[15] Our findings demonstrated that the mean serum cholesterol levels of patients who died were significantly lower than those who survived. However, there was no significant difference in the mean levels of HDL-C, LDL-C, and TG between dead patients and survivors. In critically ill surgical patients, hypocholesterolemia is an independent predictor of mortality.[10] According to Lekkou and others, patients with severe sepsis had significantly higher TC and HDL-C concentrations than non-survivors. Therefore, in severely septic patients, low cholesterol and lipoprotein concentrations can be employed as early, independent prognostic markers of poor outcome and mortality.[9] Tanaka and colleagues investigated the relationship between the lipid profile and outcome in 205 septic patients hospitalized in the ICU and found that low concentrations of lipoproteins were associated with 28-day mortality.[12] According to Kitazawa and others, serum total cholesterol concentration was proposed as a prognostic marker for treatment duration and 30-day mortality in patients with bloodstream infection, with a sensitivity of 100% and specificity of 39%.[22] Gu and colleagues discovered that low total cholesterol concentrations were independent predictors of mortality in critically ill surgical patients.[23] Cirstea and colleagues identified plasma HDL-C level as the best prognostic marker for adverse outcomes in a suspected sepsis cohort study. Low levels of HDL-C were found to be independently correlated with 28-day mortality and development of MODS.[17] Buckley and colleagues investigated the association of changes in multiple organ dysfunction scores with ICU mortality and reported that increased maximal and individual multiple organ dysfunction scores, as well as changes in multiple organ dysfunction scores, were associated with increased mortality.[24] Cook and others demonstrated that there were significant differences in the relative risk of organ dysfunction-related mortality among organ systems over time. Respiratory dysfunction and hepatic impairment were not significantly correlated with mortality until the second and fourth weeks of hospitalization in the ICU, respectively. Nevertheless, the cardiovascular, renal, central nervous system and hematologic four organ systems were all found to be significantly associated with ICU mortality.[25] Our findings revealed that a decrease in TC level was associated with increased dysfunction in all of the aforementioned organs. Previous studies found that HDL-C concentration at the time of ICU admission had an inverse correlation with disease severity in patients with severe acute pancreatitis and could predict chronic organ failure in this clinical setting, which was consistent with our findings.[26, 27] Tachyla and colleagues found that while TC had a medium prognostic efficiency for mortality, a combination of procalcitonin, C-reactive protein, and TC levels had a high predictive value, with a sensitivity of 89.1% and specificity of 83.1%.[28] Our findings indicated that TC and albumin combination could be employed as an appropriate biomarker for predicting mortality and organ dysfunction in critically ill patients. Mesotten and others found a relationship between serum TG, LDL-C, and HDL-C concentrations and mortality.[29] They reported an approximately linear correlation between intensive care mortality and every 100 mg/dL increase in serum TG. However, there was a cut-off level of 20 mg/dL and 15 mg/dL for LDL-C and HDL-C, respectively; mortality significantly increased below these levels,[29] which was also comparable with our findings. Gruber and colleagues demonstrated that a reduction in HDL-C was a predictor of illness severity, and low TC was predictive of adverse outcomes in critically ill patients.[30] Similar to our findings, another study found that low total cholesterol levels, but not low HDL-C, LDL-C, and TG concentrations, were independent predictors of short-term mortality in sepsis.[31] The results of this study also revealed that a decrease in the level of total cholesterol was accompanied by an increase in hospital and ICU length of stay as well as the duration of mechanical ventilation and vasopressor use. According to the results of regression analysis in this study, age, TC, TG, and albumin levels had significant effects on ICU and hospital length of stay, duration of mechanical ventilation and vasopressor use, and SOFA score. Patients with systemic inflammatory response syndrome (SIRS), who are critically ill, develop early hypocholesterolemic in their disease, which appears as an independent risk factor for mortality.[10] The majority of postoperative critically ill patients have low cholesterol and lipoprotein levels. Acute critical illness leads to the secretion of inflammatory cytokines, which results in a rapid drop in lipoprotein concentrations. Thus, following ICU admission, very low cholesterol levels are associated with increased mortality and infection rates.[32] Daily monitoring of organ dysfunction during the ICU stay provides additional prognostic information for critically ill patients. It is still unknown whether the observed changes in lipid profile have a negative impact on organ functioning. For patients with severe injuries, sequential cholesterol monitoring is recommended during their treatment. These fundamental assessments can be useful as adjunctive clinical tools, since cholesterol levels can represent altered lipoprotein patterns. Future studies may demonstrate that sequential cholesterol monitoring may enhance patient outcomes, for critically injured patients receiving surgical ICU care. The host response to inflammation in critically ill patients might be modulated as a result of changes in serum lipid metabolism following ICU admission.

This study had some limitations. This study focused on patients undergoing thoracoabdominal surgery admitted to ICU, therefore, the findings might not be generalizable. Accordingly, studies with more heterogeneous patients and larger sample sizes are required. Since the results of the lipid profile varied greatly among the different ICU populations, it is now more essential than ever to evaluate the potential therapeutic effect of lipid profiles in critically ill patients. Moreover, we did not define a cut-off point for predicting mortality or organ dysfunction in this study. Furthermore, the BMI and nutritional status of the patients were not evaluated in this study.

Conclusion

Lower total cholesterol concentrations were found to be significantly associated with an increased risk of mortality, ICU and hospital length of stay, and duration of mechanical ventilation. After adjustment for confounders, this association seemsedto have a direct effect on morbidity and mortality in critically ill patients.

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Authors' Contribution

S.S, S.D, A.M: conception and design of the work, interpretation of the data, drafting the manuscript; M.M: data acquisition and analysis, interpretation of the data, revising the manuscript; S.R: data acquisition and analysis, revising the manuscript; A.F: data acquisition and analysis, revising the manuscript; K.S: data acquisition and analysis, interpretation of the data, drafting the manuscript; E.F: data acquisition and analysis, interpretation of the data, revising the manuscript; All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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