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ARTICLE

Lactate/Albumin Ratio Could be a Prognostic Indicator for Patients with Post-operative Intestinal Obstruction

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Abstract

Objective:This study aimed to investigate the value of lactate/albumin ratio in prediction of mortality in intensive care unit (ICU) patients with post-operative intestinal obstruction. Method:A retrospective analysis was conducted with patient data from the eICU Collaborative Research Database (eICU-CRD). According to the outcome, the patients with post-operative intestinal obstruction who were admitted to ICU within 24 hours after surgery were separated into two groups: survivors (233 cases) and non-survivors (35 cases). Their clinical characteristics and scoring data were collected. Logistic regression analysis was used to evaluate the risk factors for death, and these risk factors were further included for the construction of the receiver operating characteristic curve (ROC) to evaluate the predictive value of death for these patients. Results:In-hospital mortality for patients admitted to ICU with post-operative intestinal obstruction was 13.1% (35/268). The level of lactate/albumin ratio was significantly higher in non-survivors than in survivors (1.36±1.54 versus 0.70±0.64; P<0.001). Logistic regression analysis showed that the lactate/albumin ratio (OR=0.667, 95%CI: 1.328-2.485, P=0.001) could predict in-hospital mortality independently for the patients in ICU with post-operative intestinal obstruction. Further analysis showed that the area under the ROC curve (AUC) value of lactate/albumin ratio level was 0.681. Conclusions: These data suggested that the lactate/albumin ratio has potential predictive value for mortality in ICU patients with post-operative intestinal obstruction.

Keywords: Lactate/albumin ratio; Post-operative intestinal obstruction; Prognosis; Retrospective

1. INTRODUCTION

Intestinal obstruction is a disorder in which the passage of intestinal contents is partially or completely blocked due to various reasons, causing symptoms including acute abdominal

pain, constipation, bloating, and vomiting. The onset of intestinal obstruction is often acute, and the disease progresses rapidly and may eventually lead to intestinal rupture, which is a life-threatening acute abdomen [1]. Intestinal obstruction caused by tumors and strangulated intestinal obstruction caused by other reasons (e.g., adhesions, hernia, etc.) requires prompt surgical treatments. If the patient with intestinal obstruction needs to be transferred to the intensive care unit (ICU) for resuscitation after surgical treatments, it often indicates that the condition is still serious and the prognosis is poor. Therefore, it is critical to identify prognostic factors that can help evaluate the severity of intestinal obstruction. However, so far, clinical indicators that can accurately predict the prognosis of patients with intestinal obstruction are still limited.

Severe patients with intestinal obstruction often have circulatory or respiratory insufficiency. Insufficient peripheral perfusion, tissue ischemia, and hypoxia are linked to increased glycolysis and elevated blood lactate levels [2]. The blood lactate level in critically ill patients is often related to the patient's organ function status and could be associated with their prognosis [3]. However, many factors other than tissue ischemia and hypoxia can also lead to increased blood lactate. For instance, the skeletal muscle is the main producer of lactic acid in the body [4]. The increase in skeletal muscle movement and the increase of Na+-K+-ATP pump activity can lead to elevated lactic acid production [5]. Moreover, liver and kidney dysfunction can also result in blood lactic acid excretion disorder. Therefore, although the blood lactate level can be used as a prognostic factor for patients with intestinal obstruction, the combination of blood lactate level and other indicators may further help improve the prediction efficiency.

Albumin is a negative acute-phase protein and its level often reflects the severity of a patient's inflammatory response. Patients with chronic inflammatory diseases usually have hypoalbuminemia. Therefore, the blood albumin level could be utilized as a marker for evaluation of a patient's long-term physical condition [6]. Post-operative albumin levels in patients with intestinal obstruction can be affected by the following factors. First, insufficient or inability to eat before surgery can lead to malnutrition and hypoalbuminemia in a patient. Moreover, body stress and inflammatory response due to major abdominal surgery can affect albumin levels [7]. For these patients, the albumin in the body is consumed in large quantities and penetrates into the interstitial space, resulting in a negative nitrogen balance. Therefore, the albumin level after the intestinal obstruction can be a marker reflecting the patient's preoperative nutritional status and the degree of stress during the operation. Sean L. Goh et al. [8] found that hypoalbuminemia could be linked to a significant increase in postoperative complications in patients with esophageal cancer. Studies have shown that a significant decrease in plasma albumin levels in critically ill patients often indicates a poor prognosis [9]. Blood urea nitrogen is the end product of protein metabolism [10]. Andrea. S.K et al. found that blood urea nitrogen level is related to postoperative mortality of patients, suggesting that urea nitrogen level may indicate the severity of preoperative intestinal obstruction and the presence of intestinal necrosis occurs [11].

Investigations on the relationship between blood lactate and albumin ratio and patient prognosis are mainly focusing on patients with sepsis. Compared with blood lactate level alone, the lactate/albumin ratio seems to have a better predictive value in terms of in-hospital mortality in sepsis patients [12]. There are a few studies on the prognosis of

thoracoabdominal surgery, but most of them only discussed the relationship between a single index (e.g., albumin level solely) and prognosis [13]. In this retrospective study, we aimed to investigate the predictive value of the blood lactate/albumin ratio within 24 hours after surgery for the prognosis of patients who were transferred to the ICU after post-operative intestinal obstruction.

2. METHODS Data description

The dataset used in this study is the freely available multicenter eICU collaborative research database [14], which contains information on patients admitted to intensive care units in the United States from 2014 to 2015. The dataset included data on more than 200,000 ICU admissions from more than 139,000 patients, including basic patient demographics, laboratory test results, diseases, and treatment status. Purpose

This study aimed to retrospectively study the predictive value of various examination results on the prognosis of adult ICU patients with post-operative intestinal obstruction within 24 hours after surgery in the 2014–2015 eICU Collaborative Research Database. Inclusion criteria

The inclusion criteria were as followed. First, the patient needed to be transferred to the ICU with post-operative intestinal obstruction. Second, the age of the patient was greater than or equal to 17 years old and less than 89 years old. Third, the patient had been admitted to the ICU for at least 24 hours. Exclusion criteria

The exclusion criteria were as followed. First, there was no record of whether the patient survived before discharge in the database. Second, the patient's key information, such as age and gender, was missing. Third, the patient was not admitted to the ICU for the first time. Fourth, the patient's albumin or lactate blood test results within 24 hours after surgery were not available. Data collection

Demographic data and test results within 24 hours of surgery were collected. These general parameters included gender, age, body mass index (BMI), and acute physiology and chronic health score (APACHE-IV score). The parameters of blood tests included plasma albumin (ALB), lactate (LAC), lactate/albumin ratio (LAC/ALB), white blood cell (WBC) count, mean corpuscular-hemoglobin concentration (Mch), creatinine, blood urea nitrogen (BUN), platelet count (PLT), alanine aminotransferase (ALT), prothrombin time (PT), and blood bilirubin (TBIL).

Statistical processing

Statistical analysis was performed using IBM SPSS 25.0 software. For missing values in the data, the serial mean method of SPSS software was used for replacement. Normally distributed measurement data are represented by mean ± standard deviation (SD), and the independent student's t-test was used for comparison between groups. The Wilcox test was used if the data did not meet the parametric assumptions for performing the t-test. Count data were expressed as ratios, and comparisons between groups were performed by the chi-squared test in a multiple logistic regression analysis. Receiver operating characteristic (ROC) curves for associated risk factors were drawn and the area under the curve was determined. $P<0.05$ indicated that the difference was statistically significant.

3. RESULTS

Clinical characteristics of patients with post-operative intestinal obstruction in ICU

During the study period, 268 patients with post-operative intestinal obstruction were eligible for inclusion and completed the follow-up. Demographic data and blood test results in survivors and non-survivors are shown in Table 1. Particularly, The basic information of the two groups of patients was compared, including gender, age, BMI, APACHE- score, albumin concentration (ALB), lactate (LAC), lactate/albumin ratio (LAC/ALB), white blood cell count (WBC), mean red blood cell hemoglobin concentration (mch), creatinine, blood urea nitrogen (BUN), platelet count (PLT), alanine aminotransferase (ALT), blood bilirubin (TBIL), prothrombin time (PT). Among them, there was no significant difference in terms of gender, age, BMI, WBC, mch, PLT, ALT, and TBIL ($P>0.05$). However, the parameters, including APACHE score, ALB, LAC, LAC/ALB, creatinine, BUN, and PT were statistically significant ($P<0.05$), indicating the non-survivors had impaired renal function and worsened the long-term physical condition.

Table 1. Comparison of clinical characteristics between the survival group and the non-survival group.

Parameters	Survivors (n=233)	Non-survivors (n=35)	Total (n=268)	P value
Age	69±14	74±11	70±14	0.072
Gender (M/F)	99/134	16/19	115/153	0.719
BMI	28.86±18.31	26.99±7.05	28.62±17.26	0.550
APACHE_Ⅳ	61.96±23.24	100.69±30.65	67.02±27.57	＜0.001
ALB (g/dL)	3.39±8.1	2.99±0.92	3.33±0.84	0.009
LAC (mmol/L)	2.23±1.87	3.46±3.47	2.39±2.18	0.047
LAC/ALB	0.70±0.64	1.36±1.54	0.79±0.84	＜0.001
Mch (pg)	29.75±2.75	28.97±2.92	29.64±2.78	0.124
PLT ($\times10^9$/L)	266.42±109.44	291.20±127.81	269.66±112.06	0.223
ALT (U/L)	33.81±45.70	233.73±846.82	58.62±311.83	0.194
WBC ($\times10^9$/L)	12.87±7.02	13.62±6.31	12.96±6.93	0.550
Creatinine (mg/dL)	1.37±1.08	1.98±1.60	1.45±1.18	0.038
BUN (mg/dL)	27.34±17.91	39.20±24.85	28.89±19.32	0.010
TBIL (mg/dl)	0.99±1.49	1.26±1.48	1.03±1.49	0.319
PT (second)	15.48±4.99	18.67±6.86	15.90±5.37	0.015

Note: M/F: Male/Female; BMI: body mass index; APACHE_Ⅳ: acute physiology and chronic health score; ALB: albumin; LAC: lactate; Mch: mean red blood cell hemoglobin concentration; PLT: platelet; ALT: alanine aminotransferase; WBC: white blood cell; BUN: blood urea nitrogen; TBIL: blood bilirubin; PT: prothrombin time.

Logistic regression analysis of prognosis of patients with postoperative intestinal obstruction

Next, we included age, gender, and parameters that were statistically different (LAC/ALB, creatinine, blood urea nitrogen, and prothrombin time) in the Logistic regression analysis. Because the APACHE IV score was collinearly correlated with albumin, serum creatinine, and other factors, this study did not use the APACHE IV score as a factor in logistic regression

analysis. The analytic results showed that LAC/ALB and urea nitrogen BUN were the risk factors for postoperative intestinal obstruction patients, and the difference was statistically significant (P<0.05) (Table 2).

Table 2. Logistic regression analysis parameters

Parameters	B	SE	Wald	P value	Exp (B)	95%CI
Age	0.025	0.017	2.198	0.138	1.026	0.992-1.060
Gender (M/F)	-0.104	0.392	0.070	0.792	0.902	0.418-1.945
LAC/ALB	0.645	0.203	10.071	0.002	1.906	1.280-2.840
Creatinine (mg/dL)	0.019	0.182	0.011	0.917	1.019	0.713-1.457
BUN (mg/dL)	0.025	0.012	4.568	0.033	1.025	1.002-1.049
PT (second)	0.027	0.033	0.686	0.408	1.027	0.964-1.096

ROC curve prediction value

As shown in Figure 1 and Table 3, The Area under the ROC Curve (AUC) values of LAC/ALB and BUN were 0.681 and 0.642, respectively. Therefore, compared to BUN, LAC/ALB has a better predictive value for in-hospital mortality in post-operative patients admitted to the ICU after intestinal obstruction.

Table 3. ROC curves of various factors for predicting the death group of patients with postoperative intestinal obstruction

Parameters	AUC	SE	P Value	95%CI
LAC/ALB	0.681	0.048	0.001	0.588-0.776
BUN	0.642	0.055	0.007	0.535-0.749

Note: AUC: Area under the ROC Curve.

4. DISCUSSION

With the continuous advancement of medical technology, the success rate of surgical treatment of intestinal obstruction has improved. However, some patients could not benefit from the surgical treatments and mortalities could still occur. Good indicators to predict the prognosis of these patients may help improve their outcomes. In this study, we found that the lactate/albumin ratio within 24 hours after surgery can be used as an independent predictor of mortality risk in patients who need to be admitted to the ICU after intestinal obstruction.

For patients with normal liver and kidney function, blood lactate levels often reflect the balance of oxygen supply in their body [15]. A large number of publications have confirmed that the blood lactate level of patients is an independent risk factor affecting the prognosis of patients [16]. Blood lactate is easy to obtain and interpret with good reproducibility and low cost. However, since blood lactate levels can be affected by multiple factors, using blood lactate alone as a predictor of prognosis is not accurate in the clinic.

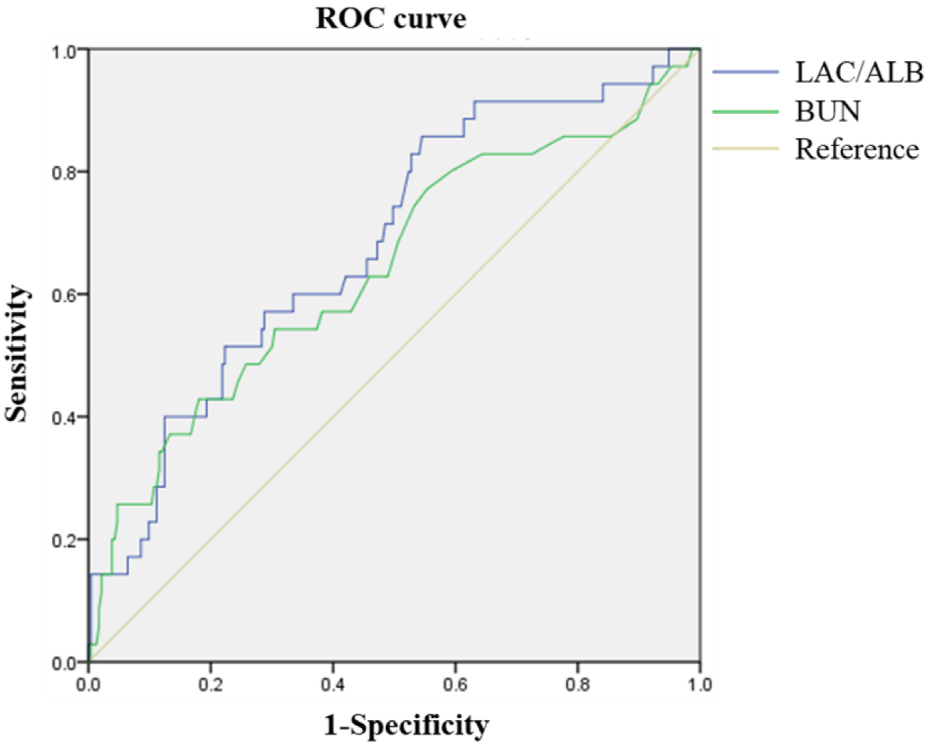

Figure 1. The ROC curve of each factor predicting the survival outcome of postoperative patients with intestinal obstruction.

Albumin is the main component to maintain plasma colloid osmotic pressure. It has the functions of maintaining intravascular colloid osmotic pressure, regulating the dynamic balance of water between tissues and blood vessels, and carrying hormones and other substances. Hypoproteinemia can cause complications such as various physiological dysfunctions, pulmonary interstitial edema, intestinal wall edema, postoperative anastomotic leakage, and an increase in the mortality rate of patients [13].

In patients with postoperative intestinal obstruction, due to factors such as surgical shock and pain stimulation, the body is often stressed, which makes the patient in a state of hypermetabolism and causes hypoproteinemia [17]. At the same time, the stress of major surgery causes cascade-like release of inflammatory factors, such as tumor necrosis factor- (TNF-), vascular endothelial growth factor (VEGF), which causes inflammatory response, vascular endothelial cell damage, increased vascular permeability, accelerated extravascular extravasation of albumin, and resulting in hypoalbuminemia. In addition, under severe physical stress, the liver preferentially synthesizes acute phase proteins by reducing albumin synthesis, exacerbating the development of hypoalbuminemia. Therefore, the plasma albumin level not only reflects the long-term nutritional status of the patient, but also reflects the recent stress and infection of the patient, which can directly reflect the critical state of the patient.

Several previous studies have explored the predictive value of lactate/albumin ratio in

critically ill patients [18], but most of these studies focused on patients with sepsis [19]. In addition, several studies have explored albumin as a predictive prognostic marker for major abdominal surgery. In a multicenter study, Daniel P Park et al. [13] analyzed 7227 postoperative esophageal cancer patients in England, Wales and Northern Ireland from 1995 to 2007 and found that postoperative serum albumin levels were an important predictor of mortality risk. Jorge Henrique Bento de Sousa et al. [20] found that hypoalbuminemia in patients with postoperative intestinal obstruction was often associated with high postoperative mortality. Studies have found [21] that hypoalbuminemia is an important factor affecting the prognosis of patients with pneumonia, patients after esophageal cancer surgery, and patients after major abdominal surgery.

This study found that the ratio of lactate/albumin (OR=0.667, 95%CI: 1.328-2.485, P=0.001) could independently predict the in-hospital mortality of patients with intestinal obstruction. Its ROC curve value was 0.681, indicating that lactate/albumin ratio has a good predictive value for in-hospital mortality.

5. CONCLUSION

Early blood lactate/albumin ratio could be an independent predictor of in-hospital mortality risk in patients transferred to ICU for resuscitation after post-operative intestinal obstruction.

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