Contents available at **PubMed**
www.clinicalandtranslationalinvestigation.com

Check for updates

Rev Invest Clin. 2022;74(2):97-103 ORIGINAL ARTICLE

The Prognostic Value of C-Reactive Protein/Albumin Ratio in Acute Pulmonary Embolism

Sevgi Özcan[1], Esra Dönmez[1]*, Sevil Yavuz Tuğrul[2], İrfan Şahin[1], Orhan İnce[1], Murat Ziyrek[1], Sinan Varol[1], Serkan Karahan[1], and Ertuğrul Okuyan[1]

Cardiology Department, [1]Bagcilar Training and Research Hospital, Istanbul and [2]Basaksehir Cam and Sakura City Hospital, Istanbul, Turkey

ABSTRACT

Background: Serum C-reactive protein (CRP) to albumin ratio (CAR) has been defined as an inflammation-based prognostic marker. We evaluated the association and prognostic value of CRP/albumin ratio in patients with pulmonary embolism (PE). **Methods:** A total of 256 patients with acute PE who were hospitalized between March 2016 and December 2020 were retrospectively reviewed. PE severity index (PESI) was calculated. Serum levels of CRP and albumin that were obtained at the time of admission were used for calculation. CAR was evaluated for correlation with PESI, and thus, foresee the risk of death due to PE. **Results:** There were 186 patients eligible for inclusion. 54 patients were in intermediate, 34 patients were in high risk and 98 patients were in very high-risk group according to PESI score. In the correlation analysis, we observed moderate positive correlations between CRP/albumin ratio, troponin and PESI score ($r = 0.584$, $p < 0.0001$; $r = 521$, $p < 0.0001$, respectively). Regression analysis revealed that only CRP/albumin ratio and PESI score were independent risk factors associated with 6-month mortality of acute PE patients. The AUC for CRP/albumin ratio was 0.643, 0.751, and 0.763 for 30-day, 90-day, and 6-month mortality, respectively (95% CI: 0.550-0.737, 0.672-0.830, 0.687-0.838]. A cut-off value of 5.33 for CRP/albumin ratio was associated with 65.3% sensitivity and 65.6% specificity in predicting 6-month mortality. **Conclusion:** The CRP/albumin ratio, an inexpensive and easily measurable laboratory variable, may be a useful prognostic marker of PE, especially when other causes that alter serum levels are excluded from the study. (REV INVEST CLIN. 2022;74(2):97-103)

Keywords: Pulmonary embolism. CRP. Albumin. Ratio. PESI.

INTRODUCTION

Acute pulmonary embolism (PE) is one of the manifestations of venous thromboembolism and is the third most frequent acute cardiovascular event, accounting for approximately 5-10% of deaths in hospitalized patients[1,2]. However, the mortality rates change between groups according to clinical and radiological findings; in intermediate-risk PE, the expected mortality rate was 3-8% whereas in high-risk PE, as much as 25-52%[3]. The PE severity index (PESI) determines early mortality risk in patients and is

***Corresponding author:**
Esra Dönmez
E-mail: dresradonmez@yahoo.com

Received for publication: 24-10-2021
Approved for publication: 24-12-2021
DOI: 10.24875/RIC.21000547

calculated as part of the risk stratification process according to European Society of Cardiology (ESC) PE Guidelines[4]. This risk score is solely based on clinical parameters; however, various studies have shown that sensitivity can be enhanced using biomarkers such as high-sensitivity cardiac troponin I and N- terminal pro- brain natriuretic peptide[5-7].

Inflammation promotes thrombosis and plays a key role in the pathophysiology of PE[8]. C-reactive protein (CRP) is an acute phase reactant that is produced by the liver and induced by several cytokines. A previous research showed that high CRP levels correlate with sepsis and mortality in critically ill patients[9]. Moreover, CRP has been investigated for the diagnosis, follow-up and prognosis of PE[6,10]. Serum albumin is another protein produced by the liver; it is a negative acute phase reactant and negatively correlates with inflammatory processes[11]. It also plays an anti-inflammatory, antioxidant, anticoagulant, and antiplatelet aggregation role[12]. The CRP/albumin ratio (CAR) has been defined as an inflammation-based prognostic marker, and the relationship between CRP and albumin levels is thought to indicate the prognosis of critical diseases and malignancies[13,14] and various cardiovascular disorders[15,16]. According to the best of our knowledge, there has been no study in the medical literature in English that looked at the association and the prognostic value of the CRP/albumin ratio in patients with PE. Therefore, we aimed to evaluate the prognostic role of CAR in patients with acute PE.

METHODS

Study design

In this study, a total of 256 patients with acute PE who were hospitalized from 1 March 2016 to 30 December 2020 were reviewed retrospectively. Acute PE was diagnosed with Computed Tomography (CT) angiography or pulmonary angiography. Exclusion criteria were: < 18 years of age, previous diagnosis of autoimmune disease, active infection (pulmonary, urinary tract, etc.), malignancy, acute transient ischemic attack (TIA)/stroke, albuminuria, and chronic liver disease. Albumin replacement therapy in the past 6 months, and lack of serum CRP or albumin levels in laboratory results were also exclusion criteria. The study protocol was approved by the institutional ethics committee and was conducted in accordance with the Declaration of Helsinki.

Data collection

Demographic and clinical data were recorded by reviewing the electronic database. PESI was calculated based on the initial clinical parameters. Patients were classified according to their final scores: ≤ 65, class I (very low risk); 66–85, class II (low risk); 86–105, class III (intermediate risk); 106-125, class IV (high risk); > 125, class V (very high risk). In-hospital mortality and 6-month mortality were assessed. PE-related parameters such as treatment with thrombolytic agents, positive inotrope therapy or mechanic ventilation requirement were noted.

Blood samples were obtained on admission. The albumin and CRP levels were obtained using Roche Diagnostics Cobas 8000 c502 analyzer (Indianapolis, USA). CAR was obtained by dividing the CRP level (mg/L) by the albumin (g/dL) level.

Statistical analyses

All statistical tests were conducted using the Statistical Package for the Social Sciences 19.0 for Windows (SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was used to analyze normality of the data. Continuous data are expressed as mean ± SD, and categorical data are expressed as percentages. Chi-square test was used to assess differences in categorical variables between groups. Student's t-test or Mann-Whitney U test was used to compare unpaired samples as needed. Variables having linear correlation were evaluated using Pearson's correlation test and nonlinear variables were evaluated using Spearman's correlation test. Binary logistic regression analysis was used to identify independent variables of death. For the best cut-off value of the CRP/albumin ratio and PESI, receiver operating characteristic (ROC) curves were obtained and the optimal values with the greatest total sensitivity and specificity in the prediction of death were selected. Significance was assumed at a 2-sided $p < 0.05$.

RESULTS

A total of 186 patients were enrolled. Overall, 54 patients were in the intermediate risk, 34 patients in high risk, and 98 patients were in the very high-risk group according to PESI score. We formed two groups according to 6-month survival data of the included patients: 137 patients (86 female, 51 male) formed the survivor group; and 49 patients (33 female, 16 male) who died within 6 months formed the non-survivor group. Both groups were similar in terms of age, gender, HT, DM, CAD, congestive heart failure, COPD, and heart rate at admission (Table 1). However, the numbers of patients having systolic blood pressure lower than 100 mmHg, ventilation rate higher than 30 times/min, and body temperature < 36°C were significantly higher in the non-survivor group (51.09% vs. 73.46%, p = 0.002; 9.48% vs. 53.06%, p < 0.0001; 1.45% vs. 8.16%, p = 0.042, respectively). Concerning the biochemical parameters, glomerular filtration rate (81.31 ± 25.48 vs. 61.55 ± 24.58, p < 0.0001), plasma albumin level (3.7 ± 0.5 vs. 3.2 ± 0.6, p < 0.001), left ventricular ejection fraction (56.4 ± 4.5 vs. 53.0 ± 6.2, p < 0.001) were significantly higher; uric acid level (5.80 ± 1.91 vs. 7.06 ± 3.03, p < 0.001), PESI score (113.74 ± 44.05 vs. 175.10 ± 64.42, p < 0.0001), high-sensitivity troponin I (hs-TpI) (3 [0-51] vs. 34 [22-263], p < 0.001), CRP (5.1 [2-10] vs. 15.8 [4.8-24.6], p < 0.001), and CRP/Albumin ratio (1.57 ± 6.07 vs. 5.97 ± 6.83, p < 0.001) were significantly lower in the survivor group compared to non-survivors. Furthermore, right ventricle (RV) dimensions were significantly higher in the non-survivor group (34.8 ± 5.6 vs. 39.4 ± 5., p < 0.001). All demographical, clinical, and biochemical characteristics of the two groups are presented in detail in table 1.

In the correlation analysis, we observed moderately positive correlations between CRP/albumin ratio, troponin and PESI score (r = 0.584, p < 0.0001; r = 521, p < 0.0001, respectively) (Fig. 1). Regression analysis revealed that only CRP/albumin ratio and PESI score were independent risk factors associated with 6-month mortality of acute PE patients (Table 2).

ROC curves for accuracy of PESI score and CRP/albumin ratio for predicting 30- day, 3-month and 6-month mortality in acute PE patients are shown in figure 2. For 30-day mortality, area under the curve (AUC) for PESI score was 0.640 (95% CI: 0.543-0.737). A cut-off value of 125.5 for PESI score was associated with 57.6% sensitivity and 58.2% specificity in prediction of 30-day mortality. For 3-month mortality, AUC for PESI score was 0.815 (95% CI: 0.740-0.889). A cut-off value of 133.5 for PESI score was associated with 69.8 % sensitivity and 71.3 % specificity in prediction of 3-month mortality. AUC for PESI score was 0.813 (95% CI: 0.741-0.885). A cut-off value of 132.5 for PESI score was associated with 71.4% sensitivity and 72.2% specificity in prediction of 6-month mortality.

For 30-day mortality, AUC for CAR score was 0.643 (95% CI: 0.550-0.737). A cut-off value of 5.07 for CAR was associated with 57.6% sensitivity and 57.5% specificity in prediction of 30-day mortality. For 3-month mortality, AUC for CAR was 0.751 (95% CI: 0.672-0.830). A cut-off value of 5.35 for CAR was associated with 65.1% sensitivity and 65.0% specificity in prediction of 3-month mortality. The AUC for CRP/albumin ratio was 0.763 (95% CI: 0.687-0.838). A cut-off value of 5.33 for CRP/albumin ratio was associated with 65.3% sensitivity and 65.6% specificity in predicting 6-month mortality (Figure 2).

DISCUSSION

The aim of this study was to assess whether serum inflammatory and nutritional markers can estimate mortality in patients with acute PE. CRP (inflammatory marker), albumin (nutritional marker), and their ratio CRP/albumin were analyzed. Results showed that CRP/albumin ratios were associated with 6-month mortality in acute PE. Furthermore, a positive correlation between PESI and CAR was detected.

Present ESC guidelines recommend measuring biomarkers in patients with PE at moderate risk[4]. Results of our study supported the prognostic accuracy of the PESI risk score for all-cause 6-month mortality in patients with PE. However, from a clinical perspective, our data also suggest that combinations of PESI risk score and biomarkers (single or combined) provide a better estimation of complications.

Acute phase proteins are a class of proteins whose serum concentrations increase (positive acute phase proteins) or decrease (negative acute phase proteins)

Table 1. Demographic, biochemical, and clinical data of acute pulmonary embolism patients

Clinical characteristics	Survivor (n = 137)	Non-survivor (n = 49)	p
Age (years)	63.2 ± 15.0	67.5 ± 17.3	0.157
Male, n (%)	51 (37.22)	16 (32.65)	0.375
Heart rate > 110, beats/min, n (%)	136 (99.27)	49 (100)	0.737
Respiratory rate > 30, times/min, n (%)	13 (9.48)	26 (53.06)	< 0.0001
Systolic arterial pressure < 100, mmHg, n (%)	67 (51.09)	36 (73.46)	0.002
Saturation O_2 < 90, n (%)	108 (78.83)	42 (85.87)	0.400
Right ventricle/Left ventricle (Computerized Tomography), n (%)	83 (60.58)	38 (77.55)	0.016
Deep venous thrombosis, n (%)	26 (18.97)	14 (28.57)	0.083
Hospital stay (days)	5(3-7)	1 (1-6)	< 0.001
Intensive care unit admission, n (%)	87 (63.50)	40 (81.63)	0.013
Mental status, n (%)	2 (1.45)	20 (40.81)	< 0.0001
Patients receiving thrombolytic, n (%)	35 (25.54)	23 (46.93)	0.005
Body temperature (ºC) < 36, n (%)	2 (1.45)	4 (8.16)	0.042
Body mass index (kg/m^2)	28.89 ± 5.61	27.67 ± 4.78	0.672
Comorbidity			
Hypertension, n (%)	73 (53.28)	22 (44.89)	0.200
Diabetes Mellitus, n (%)	33 (24.08)	7 (14.28)	0.107
Coronary artery disease, n (%)	21 (15.32)	5 (10.20)	0.264
Congestive heart failure, n (%)	2 (1.45)	2 (4.08)	0.284
Malignity, n (%)	5 (3.64)	13 (26.53)	< 0.0001
Chronic obstructive pulmonary disease, n (%)	20 (14.59)	3 (6.12)	0.093
Cerebrovascular Incident, n (%)	6 (4.37)	3 (6.12)	0.011
Laboratory findings			
Hemoglobin (g/dL)	12.2 ± 1.9	12.3 ± 2.0	0.816
Platelets	231.3 ± 69.5	243.2 ± 90.4	0.408
Leukocytes (103 /µL)	10.1 ± 3.2	11.7 ± 3.9	0.319
Neutrophiles	9.0 ± 4.4	10.1 ± 4.2	0.480

(Continues)

Table 1. Demographic, biochemical, and clinical data of acute pulmonary embolism patients *(continued)*

Clinical characteristics	Survivor (n = 137)	Non-survivor (n = 49)	p
Laboratory findings			
Lymphocytes	2.5 ± 1.1	3.0 ± 1.4	0.057
Red cell distribution width	14.1 ± 1.7	14.8 ± 3.1	0.091
Platelet distribution width	14.7 ± 5.1	13.4 ± 3.0	0.175
Serum creatinine (mg/dL)	1.01 ± 0.89	1.12 ± 0.41	0.385
Glomerular filtration rate (CPK-EPI)	81.31 ± 25.48	61.55 ± 24.58	< 0.0001
Sodium (mmol/L)	138.7 ± 3.9	136.6 ± 6.3	0.017
Potassium (mmol/L)	4.3 ± 0.5	4.5 ± 0.6	0.059
Glucose (mg/dL)	153.0 ± 71.9	171.9 ± 57.8	0.171
Albumin	3.7 ± 0.5	3.2 ± 0.6	< 0.001
Uric acid	5.80 ± 1.91	7.06 ± 3.03	< 0.001
Pulmonary embolism severity index	113.74 ± 44.05	175.10 ± 64.42	< 0.0001
C-reactive protein (mg/dL)	5.1 (2-10)	15.8 (4.8-24.6)	< 0.001
High-sensitivity Troponin I (Normal range < 14 pg/mL)	3 (0-51)	34 (22-263)	< 0.001
D-dimer (ng/mL)	5 (2-8)	7 (5-8)	0.237
CRP/Albumin	1.57 ± 6.07	5.97 ± 6.83	< 0.0001
Left ventricular ejection fraction	56.4 ± 4.5	53.0 ± 6.2	< 0.001
Left ventricular dimension (LVD)	44.6 ± 4.6	44.0 ± 4.6	0.523
Right ventricular dimension (RVD)	34.8 ± 5.6	39.4 ± 5.1	< 0.001
RVD/LVD	0.8 ± 0.4	0.9 ± 0.1	0.454
Pulmonary artery systolic pressure	46.6 ± 10.9	54.3 ± 9.7	< 0.001

Figure 1. Graphs show the correlation between PESI score and **(A)** high-sensitivity troponin-I level. **(B)** CRP/albumin ratio.

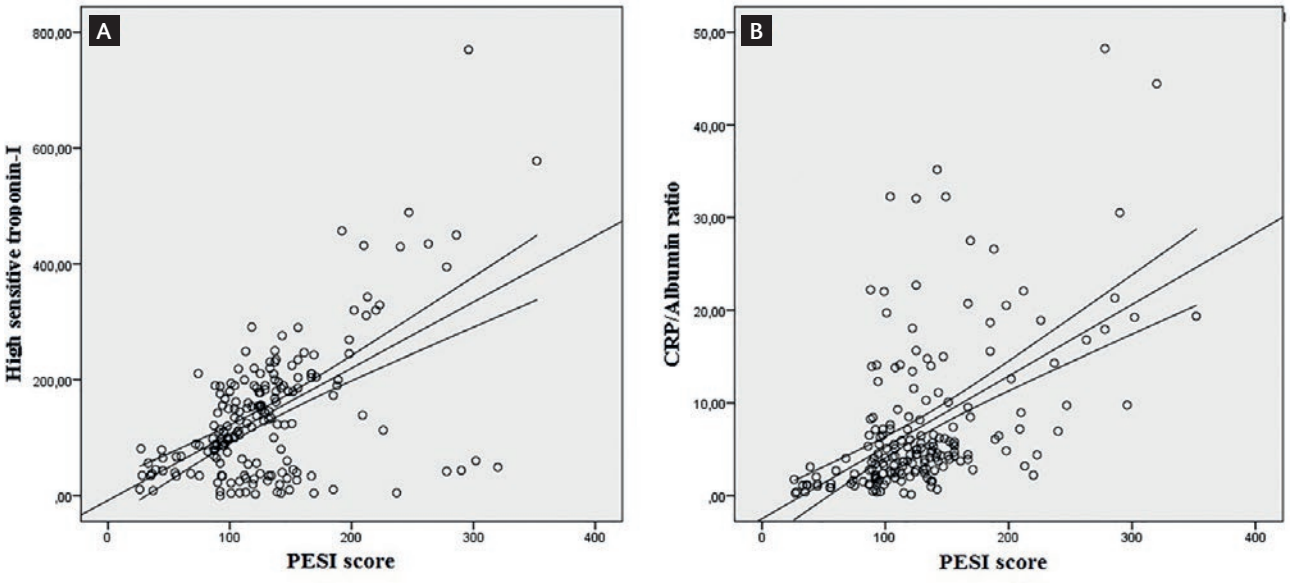
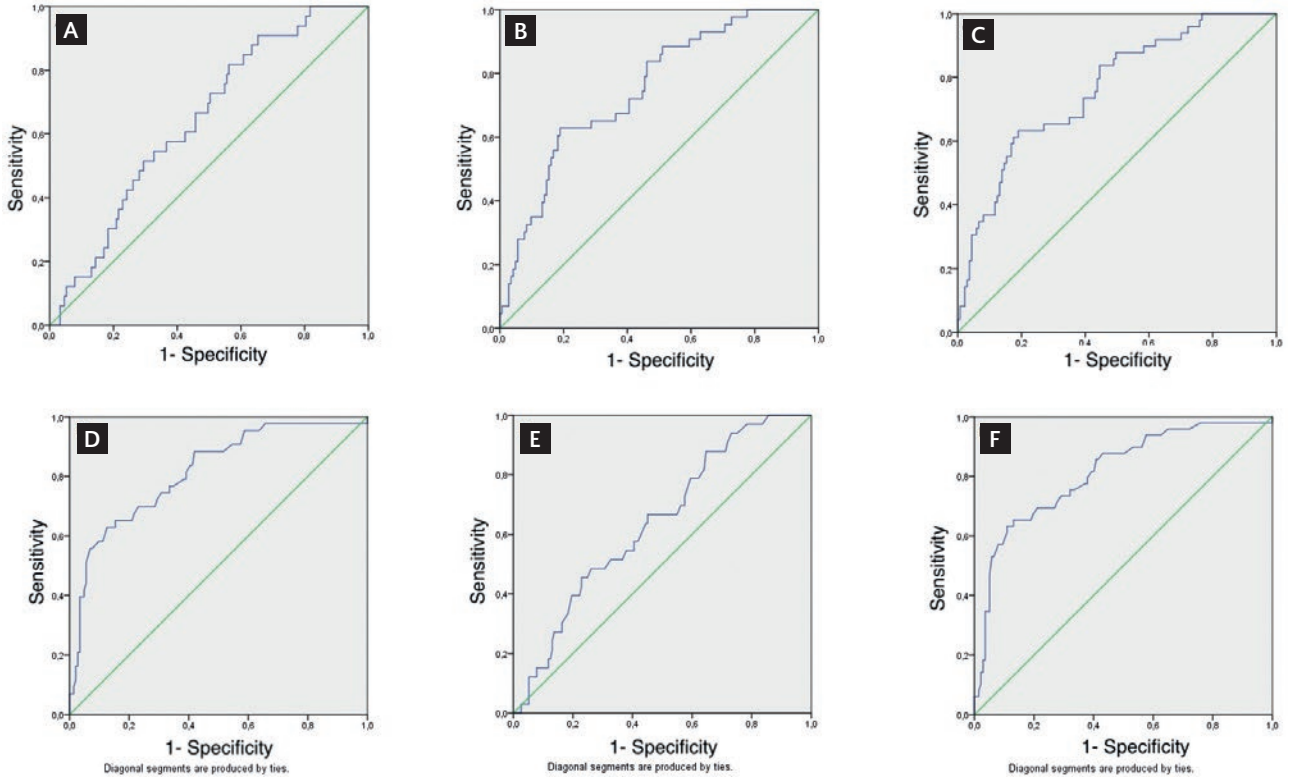


Table 2. Binary logistics regression analysis on the risk factors associated with mortality in patients with acute pulmonary embolism

Variable	Beta	95% CI	p
CRP/albumin ratio	−0.80	0.872-1.078	**0.006**
Troponin	0.002	0.994-1.004	0.926
Left ventricular ejection fraction	0.58	0.982-1.144	0.134
PESI score	−0.14	0.975-1.118	**0.027**

Figure 2. ROC curves of the performance of CAR for diagnosing **(A)** 30-day, **(B)** 90-day, and **(C)** 6-month mortality. ROC curve analysis of the performance of PESI scores for diagnosing **(D)** 30-day, **(E)** 90-day, and **(F)** 6-month mortality.



in response to inflammation[9]. CRP is the first defined positive acute phase protein and is a sensitive marker of systemic inflammation[17,18]. On the other hand, serum albumin is a negative acute phase protein, such as transferrin and transthyretin[19]. Numerous clinical studies have established that hypoalbuminemia is a powerful prognostic marker in the general population as well as in many diseases[12]. Low serum albumin is independently and inversely correlated and a strong prognostic marker in different cardiac conditions such as coronary artery disease, heart failure, atrial fibrillation, stroke and venous thromboembolism[20-22]. Furthermore, its prognostic value persists after correcting malnutrition and inflammation[12].

Cardiovascular disease and venous thromboembolism (VTE) are closely linked conditions that have common risk factors and may have common pathophysiological mechanisms[22-24]. CAR has recently been explored as a potential index to predict significant cardiovascular outcomes in a series of clinical entities[9,14]. CAR contains both CRP and albumin, and therefore, has the advantage of reflecting not only proinflammatory status but also nutritional status. Prognostic nutritional

index, which contains albumin as the nutritional component, has already been found to be a prognostic parameter at short- and long-term follow-up of PE patients[25] that correlates with our findings, emphasizing the role of combined inflammatory and nutritional status on prognosis. Recent studies evaluating CAR in patients with CVD had been encouraging. Accordingly, we showed that although CAR has lower sensitivity than PESI risk score in estimating mortality risk in PE, it has similar specificity. CAR has the potential to predict mortality in patients with PE, but its clinical applicability has yet to be proven with an internal validation cohort. Furthermore, using CAR, it is possible to modify our therapy to identify high-risk patients and to deal with possible high-risk-related adverse events in patients with PE. It can be speculated that the higher specificity of CAR is attributed to the advantage of containing two important inflammatory biomarkers.

Our study has some limitations. First of all, this is a retrospective study, and it has all the related down sides such as selection bias, lack of control of all variables and patient fall-out. Secondly, it includes a relatively small number of patients, which may explain lower sensitivity and specificity for validated PESI score. Furthermore, all data are based on a single measurement and may not reflect the relationship of CRP/albumin ratio and PE for changes over time, as follow-up measurements are not available. Definitely, larger and prospectively designed studies are needed to demonstrate the relationship between CRP/albumin ratio and PE. Biomarkers such as hs-CRP, BNP, and pro-BNP may increase the predictive power.

In conclusion, the results of our study showed decreased albumin levels and increased CRP levels in patients with PE, although both were still within the normal range. These results reinforce the role of inflammation in PE. The CRP/albumin ratio, an inexpensive and easily measurable laboratory variable, may be a useful prognostic marker of PE, especially when other causes that alter serum levels are excluded from the study.

REFERENCES

1. Raskob GE, Angchaisuksiri P, Blanco AN, Buller H, Gallus A, Hunt BJ, et al. Thrombosis: a major contributor to global disease burden. Arterioscler Thromb Vasc Biol. 2014;34:2363-71.
2. Iskandar JP, Hariri E, Kanaan C, Kassis N, Kamran H, Sese D, et al. The safety and efficacy of systemic versus catheter-based therapies: application of a prognostic model by a pulmonary embolism response team. J Thromb Thrombolysis. 2021; 10.1007/s11239-021-02576-3.
3. Amini S, Bakhshandeh H, Mosaed R, Abtahi H, Sadeghi K, Mojtahedzadeh M. Efficacy and safety of different dosage of recombinant tissue-type plasminogen activator (rt-PA) in the treatment of acute pulmonary embolism: a systematic review and meta-analysis. Iran J Pharm Res. 2021;20:441-54.
4. Konstantinides SV, Meyer G. The 2019 ESC guidelines on the diagnosis and management of acute pulmonary embolism. Eur Heart J. 2019;40:3453-5.
5. Lankeit M, Kempf T, Dellas C, Cuny M, Tapken H, Peter T, et al. Growth differentiation factor-15 for prognostic assessment of patients with acute pulmonary embolism. Am J Respir Crit Care Med. 2008;177:1018-25.
6. Abul Y, Karakurt S, Ozben B, Toprak A, Celikel T. C-reactive protein in acute pulmonary embolism. J Investig Med. 2011;59:8-14.
7. Araz O, Ucar EY, Yalcin A, Kelercioglu N, Meral M, Gorguner AM, et al. Predictive value of serum Hs-CRP levels for outcomes of pulmonary embolism. Clin Respir J. 2016;10:163-7.
8. Marongiu F, Mameli A, Grandone E, Barcellona D. Pulmonary thrombosis: a clinical pathological entity distinct from pulmonary embolism? Semin Thromb Hemost. 2019;45:778-83.
9. Lelubre C, Anselin S, Boudjeltia KZ, Biston P, Piagnerelli M. Interpretation of C-reactive protein concentrations in critically ill patients. Biomed Res Int. 2013;2013:124021.
10. Mitchell AM, Nordenholz KE, Kline JA. Tandem measurement of D-dimer and myeloperoxidase or C-reactive protein to effectively screen for pulmonary embolism in the emergency department. Acad Emerg Med. 2008;15:800-5.
11. Eckart A, Struja T, Kutz A, Baumgartner A, Baumgartner T, Zurfluh S, et al. Relationship of nutritional status, iInflammation, and serum albumin levels during acute illness: a prospective study. Am J Med. 2020;133:713-22.
12. Arques S. Serum albumin and cardiovascular disease: state-of-the-art review. Ann Cardiol Angeiol (Paris). 2020;69:192-200.
13. Bai M, Wu Y, Ji Z, Wang S, Lin Z, Pan S, et al. Prognostic value of C-reactive protein/albumin ratio in neurocritically ill patients. Minerva Anestesiol. 2019;85:1299-307.
14. Chen Z, Shao Y, Fan M, Zhuang Q, Wang K, Cao W, et al. Prognostic significance of preoperative C-reactive protein: albumin ratio in patients with clear cell renal cell carcinoma. Int J Clin Exp Pathol. 2015;8:14893-900.
15. Cinar T, Cagdas M, Rencuzogullari I, Karakoyun S, Karabag Y, Yesin M, et al. Prognostic efficacy of C-reactive protein/albumin ratio in ST elevation myocardial infarction. Scand Cardiovasc J. 2019;53:83-90.
16. Aksu U, Gulcu O, Aksakal E, Kalkan K, Ozturk M, Korkmaz AF, et al. The association between CRP/albumin ratio and in-stent restenosis development in patients with ST-segment elevation myocardial infarction. J Clin Lab Anal. 2019;33:e22848.
17. Cetin M, Zencir C, Tasolar H, Baysal E, Balli M, Akturk E. The association of serum albumin with coronary slow flow. Wien Klin Wochenschr. 2014;126:468-73.
18. Pepys MB, Baltz ML. Acute phase proteins with special reference to C-reactive protein and related proteins (pentaxins) and serum amyloid A protein. Adv Immunol. 1983;34:141-212.
19. Ritchie RF, Palomaki GE, Neveux LM, Navolotskaia O, Ledue TB, Craig WY. Reference distributions for the negative acute-phase serum proteins, albumin, transferrin and transthyretin: a practical, simple and clinically relevant approach in a large cohort. J Clin Lab Anal. 1999;13:273-9.
20. Arques S, Ambrosi P. Human serum albumin in the clinical syndrome of heart failure. J Card Fail. 2011;17:451-8.
21. Paar M, Rossmann C, Nusshold C, Wagner T, Schlagenhauf A, Leschnik B, et al. Anticoagulant action of low, physiologic, and high albumin levels in whole blood. PLoS One. 2017;12:e0182997.
22. Prandoni P, Bilora F, Marchiori A, Bernardi E, Petrobelli F, Lensing AW, et al. An association between atherosclerosis and venous thrombosis. N Engl J Med. 2003;348:1435-41.
23. Braekkan SK, Mathiesen EB, Njolstad I, Wilsgaard T, Stormer J, Hansen JB. Family history of myocardial infarction is an independent risk factor for venous thromboembolism: The Tromso study. J Thromb Haemost. 2008;6:1851-7.
24. Glynn RJ, Rosner B. Comparison of risk factors for the competing risks of coronary heart disease, stroke, and venous thromboembolism. Am J Epidemiol. 2005;162:975-82.
25. Hayiroglu MI, Keskin M, Keskin T, Uzun AO, Altay S, Kaya A, et al. A novel independent survival predictor in pulmonary embolism: prognostic nutritional ındex. Clin Appl Thromb Hemost. 2018;24:633-9.