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Impact of a scoring system based on serum alkaline phosphatase and pleural fluid lactate dehydrogenase on survival in malignant pleural effusion

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Abstract:

BACKGROUND AND AIM: Malignant pleural effusion (MPE) is a common complication of cancer and is associated with poor prognosis. This study aimed to investigate the effect of a scoring system (alkaline phosphatase-lactate dehydrogenase [AL] score), created by combining serum alkaline phosphatase (sALP) and pleural fluid lactate dehydrogenase (pLDH), on survival in patients with MPE.

METHODS: This single-center retrospective study included patients with confirmed MPE. The association between the AL score and overall survival (OS) was analyzed.

RESULTS: A total of 231 patients were included. The median OS was 9.92 months in patients with an AL score of 0–1, and 4.96 months in those with an AL score of 2 (hazard ratio: 1.50, 95% confidence interval: 1.053–2.163, p=0.02). In multivariate analysis, age, LENT score [Pleural fluid LDH (lactate dehydrogenase), ECOG (Eastern Cooperative Oncology Group) performance status, neutrophil-to-lymphocyte ratio, and tumor type score], and AL score were associated with OS (p=0.032, p=0.001, and p=0.03, respectively).

CONCLUSIONS: To our knowledge, this is one of the few studies in the literature to evaluate the AL score in the context of MPE. The AL score can be used to predict survival in patients with MPE. Because it is easy to calculate and provides rapid results, it is considered useful for guiding clinicians in the early stages of management.

Keywords:

Malignant pleural effusion, score, survival

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Introduction

Malignant pleural effusion (MPE) is characterized by the presence of malignant cells in the pleural fluid and is a common complication of cancer.[1] It occurs in approximately 15% of all malignancies.[2] The global rise in cancer incidence, along with advancements in treatment options, has improved survival in many cancer types; however, it is also believed to have contributed to an increased incidence of MPE.[3] MPE can occur in various malignancies, with the most common being lung cancer, breast cancer, and lymphomas.[4] It typically presents as a large, unilateral exudative effusion. MPE is associated with a poor prognosis, with life expectancy usually less than 12 months, depending on tumor type.[4,5]

Management of MPE depends on prognosis. Treatment options for patients with a longer survival expectancy include permanent surgical approaches, while those for patients with a shorter survival expectancy involve palliative approaches.[4] Although the prognosis of MPE depends on tumor type, disease stage, and patient performance status, some pleural fluid parameters may also have prognostic value. Parameters associated with poor prognosis include low pleural fluid pH[6] and high pleural lactate dehydrogenase (pLDH) levels.[7] Additionally, serum inflammation markers such as C-reactive protein, albumin, neutrophil-to-lymphocyte ratio, and alkaline phosphatase (ALP) have also been reported to predict the prognosis of malignancies.[8]

Several prognostic scoring systems have been proposed for malignant pleural effusion.[9–11] In clinical practice, it is essential that such tools are both accurate and practical. The AL score offers potential advantages over more complex models, as it relies solely on two objective and routinely available laboratory parameters—serum alkaline phosphatase (sALP) and pLDH. This simplicity allows for rapid and feasible risk stratification, particularly in resource-limited settings. Both sALP and pLDH have individually been associated with poor prognosis in various malignancies.[7,12–14] Elevated sALP levels often reflect systemic tumor burden, especially in the context of liver or bone metastases, while high pLDH levels indicate local cellular injury and pleural inflammation.[12–14] Although both markers have prognostic value, data on their combined use in a scoring system for MPE remain limited.[15]

The aim of this study was to investigate the prognostic value of the alkaline phosphatase-lactate dehydrogenase (AL) score, based on the combination of sALP and pLDH, in patients with MPE.

Materials and Methods

Study population

Patients diagnosed with MPE between January 1, 2009 and December 31, 2019 were analyzed as a retrospective cohort. The study was conducted at one of the reference centers for chest diseases in Türkiye. Ethical approval was obtained from the Dr. Suat Seren Chest Diseases and Surgery Training and Research Hospital Clinical Research Ethics Committee (Registration Number: 29-12-2020/33, Approval Number: 33, Date: 29.12.2020).

Patients with a diagnosis of malignancy and confirmed MPE by pleural fluid cytology and/or pleural biopsy were included in the study.

Exclusion criteria

- Presence of any infection,
- Patients undergoing autoimmune therapy,
- Patients with pathologically or cytologically unconfirmed malignant pleural effusion,
- Patients with insufficient medical or clinical data,
- Patients with known chronic liver disease, active bone disease, or use of medications known to affect ALP or lactate dehydrogenase (LDH) levels (e.g., antiepileptics, corticosteroids), if such information was available in the medical records.

Due to the retrospective design, complete medication data were not available for all patients; this has been noted as a limitation.

Clinical and laboratory data collection

Given the retrospective design, data were extracted from institutional electronic health records and validated by two independent investigators to ensure accuracy.

Age, gender, smoking history, Eastern Cooperative Oncology Group (ECOG) performance status, weight loss, and comorbidities were recorded. Among tumor-related variables, tumor size (T), lymph node involvement (N), metastasis status (M), stage, tumor type, and pleural fluid

distribution were assessed. Laboratory analyses included serum hemoglobin (Hb), white blood cells (WBC), platelets (PLT), albumin, C-reactive protein (CRP), LDH, ALP, and pleural fluid total protein (TP), albumin, LDH, and adenosine deaminase (ADA). Weight loss was defined as a loss of more than 10% of body weight within six months. Due to the retrospective design, some clinical variables were missing for a small proportion of patients.

Patients diagnosed with lung cancer were staged according to the Tumor, Node, Metastasis (TNM) 8th edition staging system.[16] The development of MPE defines Stage IV disease in lung cancer; therefore, staging was performed at the time of diagnosis, as MPE was not present in all patients initially.

AL score

AL scoring was performed at the time of MPE diagnosis for all patients. The score was calculated based on threshold values for sALP and pLDH. If both sALP (>120 U/L) and pLDH (>248 U/L) were above their respective thresholds, 2 points were assigned; if only one was elevated, 1 point was assigned; and if both values were within the normal range, 0 points were assigned. The cut-off values for sALP (>120 U/L) and pLDH (>248 U/L) were based on the upper limits of normal defined by our hospital's central laboratory, in accordance with the rationale proposed by Shi et al.,[15] allowing for local adaptation of the AL score.

LENT score

The LENT score was calculated using pleural fluid LDH, ECOG performance status, serum neutrophil-to-lymphocyte ratio (NLR), and tumor type.[17] For pleural LDH, values >1500 were assigned 1 point, while values <1500 were assigned 0 points. ECOG scores were assigned as follows: ECOG 0=0 points, ECOG 1=1 point, ECOG 2=2 points, and ECOG 3 or 4=3 points. For the serum neutrophil-to-lymphocyte ratio, values <9 were assigned 0 points, and values >9 were assigned 1 point. Tumor types were scored as follows: mesothelioma or hematologic malignancy = 0 points; breast, gynecologic cancers, or renal cell carcinoma = 1 point; lung cancer or any other type = 2 points. All points were then summed.

The LENT score was calculated as originally described by Clive et al.[17] Peripheral blood counts were obtained at the time of MPE diagnosis. The neutrophil-to-lymphocyte ratio was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count. All laboratory data used in the score were derived from the same institutional database to ensure consistency.

Statistical analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 23.0 (SPSS Inc., Chicago, IL). A power analysis was conducted using a significance level of 0.05, a statistical power of 80%, and an assumed medium effect size (Cohen's d = 0.5), indicating that a minimum of 128 patients would be sufficient. Continuous variables were presented as mean ± standard deviation, and categorical variables were presented as numbers and percentages. For categorical variables, comparisons between groups were performed using Pearson's Chi-Square test or Fisher's exact test, as appropriate. The normal distribution of continuous variables was assessed using graphical methods, normality tests, and sample size considerations. For comparisons of independent groups, variables with a normal distribution were analyzed using the Student's t-test, while variables not normally distributed were analyzed using the nonparametric Mann-Whitney U test. In the univariate analysis, age was dichotomized based on the cohort's mean age (64 years), which was used as a statistical cut-off to evaluate its association with survival. Overall survival (OS) and progression-free survival (PFS) analyses were performed using the Kaplan-Meier method, Log-rank test, and hazard ratios. Variables affecting OS were assessed by univariate analysis. Variables with a p-value <0.05 in the univariate analysis were included in the multivariate Cox regression model. The model was adjusted for age, ECOG performance status, weight loss, AL score, and LENT score.

For all statistical comparisons, the type I error margin was set at α=0.05, and differences between groups were considered statistically significant if the p value was less than 0.05 in a two-tailed test.

Results

Patient characteristics

A total of 231 patients were analyzed, of whom 156 (67.5%) were male. The mean age was 63.8±11.9 years. Based on ECOG performance status, the most common categories were ECOG I (n=64, 27.7%), ECOG II (n=78, 33.8%), and ECOG III (n=64, 27.7%). A total of 132 patients (57.1%) were current or former smokers. Ninety-five patients (41.1%) had at least one comorbid condition, with chronic obstructive pulmonary disease being the most common

(n=37, 16%). Regarding cancer type, 153 patients (66.2 %) had non-small cell lung cancer, 29 (12.6%) had small cell lung cancer,17 (7.4 %) had mesothelioma, and 32 (13.8%) had extrathoracic malignancies. Of the 231 enrolled patients, 167 (72.3%) experienced disease progression, and 222 (96.1%) died during clinical follow-up. The characteristic features of the patients are summarized in Table 1.

Serum and pleural fluid parameters

The median (min-max) values of serum sALP and pLDH were 116 (29–1116) and 582 (25–5959), respectively. Patients were divided into three groups based on the AL score: 0 in 38 patients (16.5%), 1 in 145 patients (62.8%), and 2 in 48 patients (20.8%). For comparative and survival analyses, patients were grouped as AL score 0–1 versus AL score 2, as reflected in Table 2.

AL score and overall survival and progression-free survival

The median OS for all patients was 8.84 months. The median overall survival was 9.92 months in patients with an AL score of 0–1, and 4.96 months in those with an AL score of 2 (p=0.02) [Fig. 1]. An AL score >1 was found to be a significant prognostic factor for overall survival in MPE patients (hazard ratio [HR]: 1.50, 95% confidence interval [CI]: 1.05–2.16, p=0.02). The median PFS for all patients was 7.46 months. The median PFS was 7.79 months in patients with an AL score of 0–1 and 6.9 months in those with an AL score of 2 (p=0.193). LENT score was also associated with OS in univariate analysis (HR: 1.58, 95% CI: 1.41–1.78, p=0.001).

In the Cox regression analysis for overall survival, significant variables included: age (HR: 1.01, 95% CI: 1.00–1.02), LENT (HR: 1.32, 95% CI: 1.12–1.55), and AL score (HR: 1.45 95% CI: 1.03–2.04) (Table 3).

Discussion

With the rising incidence of cancer, MPE is becoming an increasingly common complication. Predicting the prognosis of MPE is valuable for guiding treatment decisions; in certain patient groups, palliative support can be provided early in collaboration with the family and healthcare system. In this context, early prognostic assessment allows for individualized treatment planning. It is important that the parameters used for prognosis are easily accessible and simple to apply in daily clinical practice. The association between the AL score, developed using commonly available laboratory parameters in patients with MPE, and OS was confirmed in our study, suggesting that the AL score may be a useful tool in the routine clinical management of patients with MPE. This survival disparity underscores the clinical value of the AL score in guiding prognosis-based decisions. From a clinical perspective, this distinction may help identify patients with a poorer prognosis who could benefit from more aggressive supportive care, earlier referral to palliative care services, or closer clinical monitoring. The simplicity of the AL score further supports its potential integration into routine decision-making in the management of MPE.

Although the AL score was significantly associated with overall survival, it was not significantly correlated with progression-free survival in our study (p=0.193). This discrepancy may be explained by the fact that the AL score reflects overall tumor burden and systemic disease progression, which more directly influence long-term survival rather than early disease progression. In contrast, PFS may be influenced by treatment-specific responses, the timing of radiological evaluations, or short-term clinical factors that are not fully captured by baseline laboratory parameters such as sALP and pLDH. Therefore, while the AL score may be useful in predicting overall prognosis, it may have limited sensitivity for assessing short-term disease control.

According to the literature, both sALP and pLDH are laboratory parameters associated with the prognosis of malignancies. While several studies have evaluated the prognostic value of each marker individually, data on the combined use of both parameters are limited. LDH plays an important role in glycolysis and gluconeogenesis and has been reported as a prognostic marker in MPE.[18] Its relationship with MPE prognosis is based on the fact that energy metabolism in cancer cells differs from that in normal cells.[19] The rapid growth and proliferation of tumors increase the demand for oxygen and other host metabolites. When angiogenesis is insufficient, two types of tumor microenvironments can develop within the same tumor: oxygenated regions and hypoxic areas that rely on anaerobic glycolysis.[20] Due to hypoxia, LDH expression increases in neoplastic cells that utilize anaerobic glycolysis. These cancer cells are associated with poor prognosis, as they are linked to lymph node metastasis, shorter OS, and increased resistance to chemotherapy and radiotherapy.[21,22] Elevated LDH levels in the pleural space are associated with malignant cell proliferation and may indicate a poor prognosis for the disease.[23]

Table 1: Distribution of patients according to characteristic features and alkaline phosphatase-pleural lactate dehydrogenase (AL) score*

	Overall		AL score				p**
			0–1		2		
	n	%	n	%	n	%	
Age	63.9±11.9						NA
Gender							
Male	156	67.5	124	67.8	32	66.8	1.00
Smoking history***							
Yes	132	57.1	104	73.8	28	84.8	0.26
No	42	18.2	37	26.2	5	15.2	
Performance status (ECOG)							
ECOG 0	16	6.9	12	6.6	4	8.3	0.24
ECOG I	64	27.7	57	31.1	7	14.6	
ECOG II	78	33.8	60	32.8	18	37.5	
ECOG III	64	27.7	47	25.7	17	35.4	
ECOG IV	9	3.9	7	3.8	2	4.2	
Weight loss							
Yes	136	58.9	109	59.6	27	56.3	0.80
No	95	41.1	74	40.4	21	43.8	
Comorbid diseases***							
Hypertension	30	13	25	13.7	5	10.4	0.72
Diabetes mellitus	19	8.2	15	8.2	4	8.3	1.00
COPD	37	16	28	15.3	9	18.8	0.72
Cardiac disease	28	12.1	24	13.1	4	8.3	0.51
Others	26	11.2	20	10.9	6	12.5	0.96
T – Tumor size							
T1	37	18.5	31	19.6	6	14.6	NA
T2	47	23.5	41	25.8	6	14.7	NA
T3	39	19.5	32	20.1	7	17.1	NA
T4	76	38.5	54	34.6	22	53.7	NA
N – Lymph node involvement							
N0	31	15.5	28	17.6	3	7.3	NA
N1	2	1	2	1.3	0	0	NA
N2	89	44.5	71	44.7	18	43.9	NA
N3	77	39	57	36.5	20	48.8	
M – Metastasis status							
M0	19	9.5	12	7.5	7	17.1	NA
M1a	105	52.5	89	56	16	39	NA
M1b	17	8.5	13	8.2	4	9.8	NA
M1c	58	29.5	44	28.3	14	34.1	NA
Histological type							
SCLC	29	12.6	19	10.4	10	20.8	NA
Adenocarcinoma	128	55.4	108	59	20	41.7	NA
SCC	18	7.8	12	6.6	6	12.5	NA
NSCLC	7	3	6	3.3	1	2.1	NA
Mesothelioma	17	7.4	15	8.2	2	4.2	NA
Extrathoracic malignancy	32	13.9	23	12.6	9	18.8	NA
Distribution of PE							
Unilateral	202	87.4	162	88.5	40	83.3	0.47
Bilateral	29	12.6	21	11.5	8	16.7	

Table 1: Cont.

	Overall		AL score				p**
			0–1		2		
	n	%	n	%	n	%	
AL score							
0	38	16.5					NA
1	145	62.8					
2	48	20.8					
LENT score							
0–1	7	3					NA
2–4	153	66.3					
5–7	71	30.7					
Overall survival							
Deaths	222	96.1					NA
Progression							
Yes	167	72.3					NA

*: Data are presented as mean±standard deviation (SD) for normally distributed variables and as median [25th-75th percentile] for non-normally distributed variables. Categorical variables are presented as numbers (percentages of the total). **: p-values were calculated using Pearson's Chi-Square or Fisher's exact test, as appropriate (Fisher's exact test used when expected cell count <5). ***: Due to the retrospective nature of the study, some variables had missing data. AL: Alkaline phosphatase-lactate dehydrogenase score, ECOG: Eastern Cooperative Oncology Group, COPD: Chronic obstructive pulmonary disease, SCLC: Small cell lung cancer, SCC: Squamous cell carcinoma, NSCLC: Non-small-cell lung cancer, PE: Pleural effusion, NA: Not applicable (no statistical comparison performed)

Table 2: Distribution of laboratory parameters according to alkaline phosphatase-pleural lactate dehydrogenase (AL) score

Laboratory parameter		AL score		
	All patients	0–1	2	a
Hemoglobin	12.2 (6.9–17)	12.5 (8.4–17)	11 (6–15.5)	**0.003***
WBC (×10^9/L)	9.9 (1–39)	8.5 (1–39)	9.8 (2.2–31.3)	**0.033***
PLT (×10^9/L)	322 (56–768)	295 (84–721)	326 (56–768)	0.22
CRP (mg/L)	10.5 (0–217)	4.5 (0–122)	10.2 (0.41–217)	**0.001***
LDH (U/L) median (range)	370 (95–4968)	225 (95–1179)	350 (107–4968)	**0.001***
Albumin (g/dL)	3.5 (1.8–4.9)	3.72 (1.85–4.9)	3.30 (1.80–4.4)	**0.001***
Protein (g/dL)	6.6 (4.2–8.6)	6.80 (4.26–8.26)	6.40 (4.27–8.01)	**0.041***
Alkaline phosphatase (U/L)	116 (29–1116)	81 (29–241)	160 (106–1116)	**0.001***
Pleural fluid LDH (U/L)	582 (25–5959)	348 (25–4548)	464 (173–5959)	**0.003***
Pleural fluid ADA	10.48 (0–71)	8 (0–42)	8.5 (1–71)	0.82
Pleural fluid protein (g/dL)	4.30 (0.95–7.5)	4.50 (0.95–7.50)	4.14 (1.47–5.85)	**0.004***
Pleural fluid albumin (g/dL)	2.51 (0.51–4)	2.61(0.51–4)	2.29 (0.70–3.21)	**0.001***

Data are presented as mean ± standard deviation (SD) for normally distributed variables and as median [min-max] for non-normally distributed variables. Categorical variables are presented as numbers (percentages of the total). Continuous variables were compared using the Student's t-test for normally distributed data and the Mann-Whitney U test for non-normally distributed data. *: p-values < 0.05 were considered statistically significant and are shown in bold. WBC: White blood cell count, PLT: Platelet count, CRP: C-reactive protein, LDH: Lactate dehydrogenase, ADA: Adenosine deaminase.

In a meta-analysis, high sALP values were associated with poor survival.[12] Gaur et al.[13] found that sALP levels were higher in lung cancer patients compared to healthy controls. Studies evaluating whether serum ALP can serve as a biomarker for tumor burden *in vivo* have reported, particularly in cases of minimal or inaccessible disease, ALP may be useful for monitoring therapeutic response and may correlate with tumor cell burden and number.[14,24] The association of this enzyme, whose serum levels are sensitive even in minimal disease, with MPE prognosis is consistent with the findings of our study.

The LENT score is a validated tool for predicting prognosis in MPE. It incorporates pleural LDH, similar to the

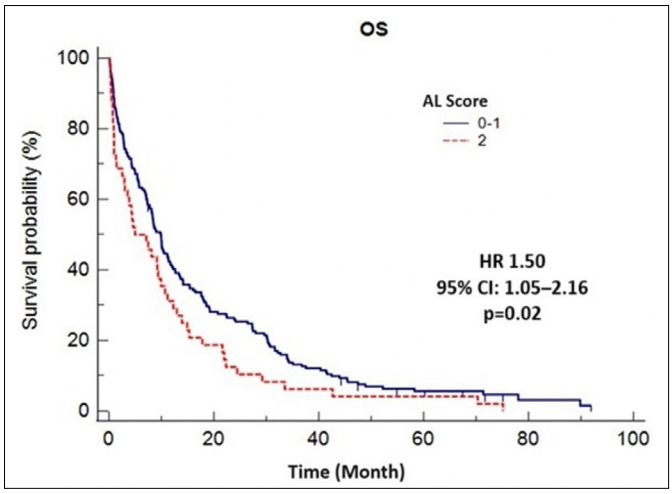

Figure 1: Kaplan-Meier analysis of overall survival
OS: Overall survival, HR: Hazard ratio, CI: Confidence interval

AL score, along with ECOG performance status, serum neutrophil-to-lymphocyte ratio, and tumor type. However, some concerns have been raised regarding the LENT score. Murray et al.[25] reported that median survival in MPE due to lung cancer remains poor despite LENT score stratification and noted that MPE arising from various malignancies may require categorization into different disease groups due to differing treatment responses. Our study extends the application of the AL score by directly comparing it to the validated LENT score in a real-world cohort of MPE patients, highlighting its potential as a practical alternative. For instance, Shi et al.[15] evaluated the AL score in a mixed cohort including patients with lung cancer and mesothelioma. Moreover, elevated sALP has been identified as a prognostic marker in breast cancer[12] and in non-small cell lung cancer (NSCLC) patients receiving immunotherapy.[8] Similarly, high pleural LDH levels have been associated with worse prognosis in lung adenocarcinoma.[7] These findings reinforce that both components of the AL score—sALP and pLDH—have been individually validated as prognostic markers across various malignancies, strengthening the rationale for their combined use in MPE. In our study, both the LENT and AL scores were identified as independent predictors of survival in multivariate analysis. Although LENT is the most well-known and validated score, the AL score stands out as a practical tool for use in malignant pleural effusion due to its fewer required parameters and ease of calculation.

To our knowledge, literature on the use of the AL score in MPE is limited. The study by Shi et al.[15] is another example that examined MPE related to lung cancer, mesothelioma, and other malignancies. Consistent with our findings, a one-point increase in the AL score was associated with poorer OS.[15] Differences in histologic types of malignancies may result in varying survival outcomes, even among different forms of the same cancer type. In our study, similar to that of Shi et al.,[15] lung cancer cases predominated, and extrathoracic malignancies were also represented in the study population. Although the prognostic utility of the AL score across globally heterogeneous patient populations is an open question, the similarity in results between studies is promising and supports the feasibility of the score. Additionally, since MPE is also common in malignancies other than lung cancer, there is a clear need for a universal prognostic score applicable across different cancer types.

This study has several limitations. First, it was conducted at a single center and used a retrospective design. Second, only patients with pathologically or cytologically confirmed malignant pleural effusion were included. Patients with very poor performance status who were unable to undergo thoracentesis were not represented. Additionally, cases with paramalignant effusions or unproven MPE were excluded. These factors may limit the generalizability of our findings to broader or more diverse clinical populations. Another limitation is that the majority of included patients (86%) had MPE secondary to lung cancer. Therefore, the results may not be applicable to patients with other types of malignancies. As noted among the limitations of this study, the predominance of lung cancer as the underlying malignancy in our cohort may restrict the external applicability of our findings. However, this distribution aligns with the established epidemiology of malignant pleural effusion, which is most frequently secondary to lung cancer, as supported by previous literature.[17,26] Accordingly, the majority of patients in our study population had MPE due to lung cancer. To enhance the robustness and broader applicability of both the AL and LENT scores, future studies should aim to validate these tools in cohorts with a more balanced representation of other malignancies, such as breast cancer, gastrointestinal tumors, and hematologic cancers. Comparative evaluation across tumor types may also reveal whether the performance of these scores varies by cancer subtype. Another limitation is that our results have not been validated in an independent cohort; therefore, future studies are needed to confirm the robustness of the AL score in MPE. Although the AL score assigns equal weight to elevated sALP and pLDH levels, this does not necessarily imply that both biomarkers have equivalent biological

Table 3: Univariate and multivariate analysis of variables affecting overall survival

	Univariate analysis		Multivariate analysis*	
	HR (CI)	p	HR (CI)	p
Age (>64 vs. <64)	1.02 (1.01–1.03)	**0.001***	1.01 (1.00–1.02)	**0.032***
Gender	0.80 (0.60–1.07)	0.14		
Smoking history (Yes vs. No)	1.01 (0.86–1.19)	0.80		
Weight loss (Yes vs. No)	1.85 (1.41–2.43)	**0.001***	1.20 (0.86–1.67)	0.27
ECOG (3–4 vs. 0–2)	2.88 (2.14–3.86)	**0.001***	1.47 (0.96–2.23)	0.07
Chronic disease (Yes vs. No)	1.19 (0.91–1.56)	0.18		
Hemoglobin (<12 vs. >12)	0.93 (0.87–1.00)	0.07		
WBC (>9.9 vs. <9.9)	1.06 (1.04–1.09)	**0.001***		
Platelet count (<322 vs. >322)	1.00 (1.00–1.00)	0.20		
CRP (>10 vs. <10)	1.00 (0.99–1.00)	0.48		
LDH (>370 vs. <370)	1.00 (1.00–1.00)	**0.001***		
Protein (<6.6 vs. >6.6)	0.73 (0.62–0.87)	**0.001***		
Albumin (<3.5 vs. >3.5)	0.52 (0.42–0.64)	**0.001***		
Pleural ADA (>10 vs. <10)	0.99 (0.98–1.01)	0.85		
Pleural protein (>4.3 vs. <4.3)	0.71 (0.61–0.83)	**0.001***		
Pleural albumin (>2.5 vs. <2.5)	0.52 (0.42–0.65)	**0.001***		
Distribution of PE (Bilateral vs. Unilateral)	1.16 (0.78–1.72)	0.40		
T – Tumor size				
T1	Reference	**0.014***		
T2	1.19 (0.76–1.87)	0.42		
T3	1.30 (0.82–2.07)	0.26		
T4	1.85 (1.22–2.80)	**0.004***		
N – Lymph node involvement				
N0+N1	Reference	**0.026***		
N2	1.76 (1.16–2.68)	**0.008***		
N3	1.42 (0.93–2.18)	0.10		
M – Metastasis				
M0	Reference	0.89		
M1a	1.19 (0.73–1.94)	0.48		
M1b	1.25 (0.64–2.43)	0.50		
M1c	1.15 (0.68–1.93)	0.59		
Histological type				
NSCLC	Reference	**0.001***		
Mesothelioma	0.82 (0.49–1.38)	0.46		
Extrathoracic malignancy	0.89 (0.59–1.35)	0.59		
SCLC	2.24 (1.47–3.39)	**0.001***		
AL score (2 vs. 0–1)	1.44 (1.04–1.99)	**0.025***	1.45 (1.03–2.04)	**0.03***
LENT score	1.58 (1.41–1.78)	**0.001***	1.32 (1.12–1.55)	**0.001***

Univariate and multivariate analyses were performed using Cox proportional hazards regression models. The Cox regression model was adjusted for age, ECOG performance status, weight loss, AL score, and LENT score. *: p-values < 0.05 were considered statistically significant and are shown in bold. HR: Hazard ratio, CI: Confidence interval, ECOG: Eastern Cooperative Oncology Group, WBC: White blood cells, CRP: C-reactive protein, LDH: Lactate dehydrogenase, ADA: Adenosine deaminase, PE: Pleural effusion, NSCLC: Non-small cell lung cancer, SCLC: Small cell lung cancer, LENT: Lactate Dehydrogenase, Eastern Cooperative Oncology Group performance status, Neutrophil-to-Lymphocyte Ratio, and Tumor type score

impacts on survival. Rather, this approach is intended to provide a simplified and practical scoring method for use in clinical settings. Another limitation of this study is the potential influence of medications or comorbidities that may affect ALP and LDH levels, which could not be fully accounted for due to the retrospective nature of the data.

Conclusion

In conclusion, to the best of our knowledge, this is one of the few studies evaluating the AL score in MPE. The AL score was found to be a useful tool for predicting survival in patients with MPE. It is considered cost-effective, as it can be calculated using a minimal number of serum markers, relies on parameters used in daily practice, and provides prognostic information. The results of the present study may encourage clinicians to incorporate the AL score into routine clinical practice for managing MPE.

Ethics Committee Approval

The study was approved by the Dr. Suat Seren Chest Diseases and Surgery Training and Research Hospital Clinical Research Ethics Committee (No: 33, Date: 29/12/2020).

Informed Consent

Informed consent was waived due to the retrospective nature of the study.

Conflicts of Interest Statement

The authors declare that there are no potential conflicts of interest.

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Use of AI for Writing Assistance

No AI technologies utilized.

Author Contributions

Concept – M.A.T., G.P.; Design – M.A.T.; Supervision – Ö.Ö., Ö.B., G.P.; Resource – M.A.T., F.G.; Materials – M.A.T., Y.Ö.; Data collection &/or processing – Ö.B., S.E., F.G.; Analysis and/or interpretation – M.A.T.; Literature search – M.A.T.; Writing – M.A.T.; Critical review – M.A.T., Ö.Ö., G.P.

Peer-review

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