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Factors Associated with Length of Hospital Stay in Pleural Empyema: A Retrospective Study

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Abstract

Objective

This study aimed to evaluate clinical, biochemical, microbiological, and treatment-related factors associated with the length of hospital stay in patients with pleural empyema.

Material and Method

Medical records of patients treated for pleural empyema between 2017 and 2025 were retrospectively reviewed. Demographic characteristics, comorbidities, pleural fluid analyses, microbiological results, and treatment modalities were analyzed. Statistical analyses included the Mann–Whitney U test, Kruskal–Wallis test, and Spearman correlation analysis.

Results

58 patients were included (82.8% male; mean age 56.0 ± 16.9 years). Surgical management was applied in 50% of cases. Chronic disease and malignancy were associated with prolonged stay (p = 0.025 and p = 0.038, respectively). Pleural fluid white blood cell levels were positively correlated with length of stay (p = 0.004).

Conclusion

This study emphasizes the importance of an early, individualized approach to the management of pleural empyema. Elevated pleural inflammatory markers and the presence of chronic disease or malignancy were associated with prolonged hospitalization. Inflammatory burden and accompanying comorbidities should be considered when selecting treatment strategies in empyema management.

Keywords: Empyema, Pleural Drainage, Pleural Effusion, Thoracic Surgery

Introduction

Pleural empyema is a severe clinical condition characterized by the accumulation of purulent fluid within the pleural space. Despite advances in antibiotic therapy and modern imaging techniques, empyema remains a significant cause of morbidity and mortality (1). It is more frequently observed in elderly or immunocompromised patients and those with comorbidities (2).

Empyema usually develops secondary to community-acquired pneumonia; however, less common etiological factors such as thoracic trauma, surgical interventions, or esophageal perforation may also be responsible (3). The progression of infection within the pleural cavity typically occurs in three stages:

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exudative, fibrinopurulent, and organizational. Treatment strategies differ according to these stages. In the early phase, antibiotic therapy and thoracentesis may be sufficient, whereas in the fibrinopurulent stage, tube thoracostomy and intrapleural fibrinolytic therapy are often employed. In the advanced organizational phase, decortication through video-assisted thoracoscopic surgery (VATS) or thoracotomy may be required (4).

In addition to clinical findings, laboratory tests and imaging methods are also crucial in the diagnostic process. Pleural fluid analysis forms the basis for the diagnosis of empyema. Elevated white blood cell (WBC) count, predominance of polymorphonuclear cells (PMNL), glucose level below 40 mg/dL, and lactate dehydrogenase (LDH) level above 1000 IU/L in pleural fluid are interpreted in favor of empyema. Additionally, pleural fluid pH below 7.20 and bacterial growth detected in culture support the diagnosis. However, the rate of identification of the causative agent in pleural fluid and blood cultures may be limited (1).

Determining the treatment strategy for empyema management depends on numerous factors. The patient's age, accompanying malignancy or chronic diseases, the stage of infection, the drainage method used (tube thoracostomy, pleural catheter, surgery), and the intrapleural lavage treatments applied can affect the prognosis. In addition, the drainage period, length of hospital stay, and pleural lavage directly affect clinical outcomes (5, 6). This study aimed to evaluate clinical, biochemical, microbiological, and treatment-related factors associated with length of hospital stay in patients with pleural empyema.

Material and Method

Study Design and Patient Selection

This retrospective observational study included patients hospitalized with pleural empyema at Süleyman Demirel University Hospital between January 2017 and January 2025. Patients aged ≥18 years with a confirmed diagnosis of pleural empyema were included in the study. Patients with incomplete medical records, missing pleural fluid analysis data, or insufficient follow-up information were excluded. In addition, three patients who died during hospitalization were excluded because complete hospitalization outcome data could not be evaluated (Fig 1).

Diagnostic Criteria

The diagnosis of pleural empyema was established based on clinical, radiological, and pleural fluid findings, in line with the British Thoracic Society guideline.

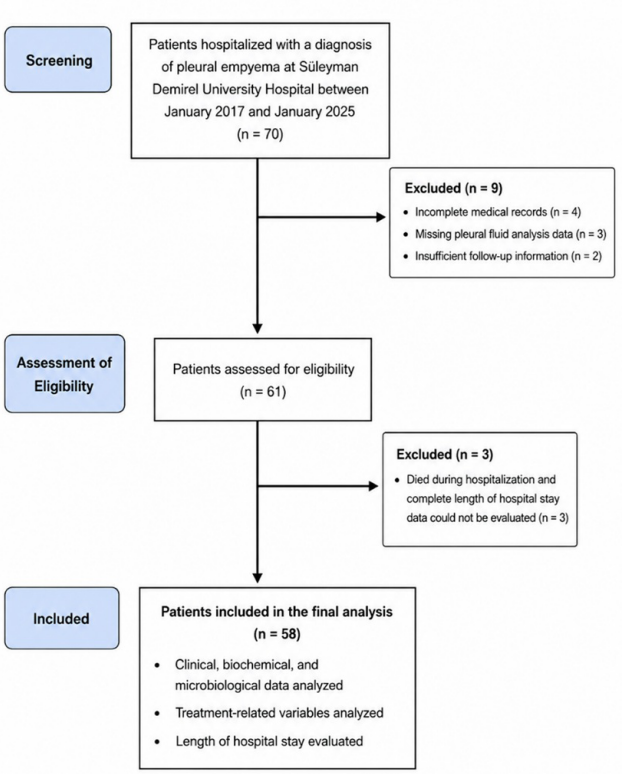


Figure 1
Flow diagram of patient selection and inclusion process in the study population with pleural empyema.

Patients with purulent pleural fluid, positive pleural fluid Gram stain or culture, pleural fluid pH <7.20, glucose <40 mg/dL, LDH >1000 IU/L, and compatible thoracic imaging findings were considered to have empyema (1). Loculation and disease stage were evaluated using thoracic computed tomography and ultrasonography findings. Patients with septations, multiloculated collections, or fibrinous pleural organization were considered to have loculated empyema. Pleural fluid samples were obtained at hospital admission and before definitive drainage procedures or surgical intervention.

Treatment Protocol

Initial treatment consisted of broad-spectrum intravenous antibiotic therapy and pleural drainage. Antibiotic regimens were selected according to suspected infection source, Gram stain findings, and microbiological culture results, and were revised according to antibiogram results when available. Tube thoracostomy was performed as the first-line drainage procedure in most patients. Pleural catheter placement was additionally preferred in patients with multiloculated empyema or inadequate drainage. Intrapleural saline lavage was performed according to the treating physician's clinical decision. Fibrinolytic therapy was not routinely administered in the study population.

Video-assisted thoracoscopic surgery (VATS) decortication was performed in patients with inadequate drainage despite tube thoracostomy, or advanced fibrinopurulent/organizational stage empyema. Thoracotomy was reserved for selected advanced cases unsuitable for VATS or requiring extensive decortication.

Primary and Secondary Endpoints

The primary endpoint of the study was the length of hospital stay. Secondary endpoints included the relationship between hospitalization duration and treatment modality, microbiological findings, pleural fluid inflammatory markers, and accompanying comorbidities.

Statistical Analysis

The data were analyzed in a computer environment using a statistical software package (SPSS 22.0). The conformity of continuous variables to normal distribution was assessed using visual methods (histograms and probability plots) and analytical methods (Kolmogorov – Smirnov / Shapiro – Wilk tests). Descriptive statistics were presented as numbers, percentages, median, 25th percentile and 75th percentile (Q1–Q3), and minimum and maximum (min–max) values. In analytical evaluations, the Mann–Whitney U test was used, while the Kruskal–Wallis test was used for variables with more than two groups. Pairwise comparisons were evaluated using the Mann–Whitney U test with Bonferroni correction. The relationship between variables that did not conform to a normal distribution was analyzed using Spearman's correlation test. In all analyses, the threshold for statistical significance was accepted as $p<0.05$. In the Results section, statistical analysis results were presented with the exact p values. Only when the p value was less than 0.001 was it expressed as $p<0.001$.

Due to the limited sample size, multivariable regression analysis was not performed because of the risk of model overfitting and unreliable estimates.

Ethical Approval

This study was approved by Suleyman Demirel University Research Ethics Committee (approval no: 09.12.2025-107-31) and was conducted in accordance with the Declaration of Helsinki. Because of the retrospective study design, the requirement for written informed consent was waived by the institutional ethics committee.

Results

The study was completed with a total of 58 patients with empyema, 82.8% of whom were male. Of the patients, 51.7% had no chronic disease and 86.2% had no malignancy. 74.1% of the participants were patients without concomitant lung infection. For the treatment of empyema, 50.0% of the patients underwent surgery, 37.9% received tube drainage, and 12.1% received pleural catheter treatment. According to the pleural culture results, no growth was observed in 51.7% of the patients, monobacterial growth was detected in 37.9%, and polybacterial growth was detected in 10.3%. In pleural fluid Gram staining, 32.8% of the patients showed Gram-positive staining.

The median age of the participants was 57.0 years (Q1–Q3: 44.75–71.25); the median length of hospital stay was 17.0 days (Q1–Q3: 11.0–21.2); the median pleural fluid WBC level was 47.2 (Q1–Q3: 6.0–176.4); the median pleural fluid LDH level was 2042.5 (Q1–Q3: 920.5–5502.25); and the median pleural fluid glucose level was 20.30 (Q1–Q3: 4.25–41.31). The descriptive characteristics of the participants are presented in Table 1 and Table 2. The length of hospital stay was longer in males than in females; however, this difference was not statistically significant ($p=0.132$). Patients with any chronic disease and those with malignancy had a significantly longer hospital stay ($p=0.025$ and $p=0.038$, respectively).

The effect of different treatment methods used for empyema treatment on the length of hospital stay was not statistically significant ($p=0.449$). The effects of pleural culture results and pleural fluid Gram staining results on the length of hospital stay were also not statistically significant ($p=0.530$ and $p=0.079$, respectively). The distribution of variables associated with the length of hospital stay is presented in Table 3 and Table 4. Pleural fluid WBC level was significantly positively correlated with length of hospital stay (rho=0.383 and $p=0.007$, respectively). Additionally, pleural fluid WBC level was significantly and moderately positively correlated with age (rho=0.409, $p=0.004$) and pleural fluid LDH level (rho=0.491, $p<0.001$). The results of the correlation analysis are presented in Table 5.

Discussion

In our clinic, the first-line treatment for pleural empyema consists of tube thoracostomy or pleural catheter placement in addition to appropriate antibiotic therapy. However, as is well established, extravasation of fibrin in empyema leads to the formation of dense pleural loculations through the interaction of components of the fibrinolytic system and profibrotic mediators, resulting in progressive complexity of the pleural space over time (2). In cases of loculation, a pleural catheter is placed in addition to tube thoracostomy if

Table 1 Distribution of the patients included in the study according to descriptive characteristics

Characteristic	n	%
Gender		
Male	48	82.8
Female	10	17.2
Chronic disease		
None	30	51.7
Present	28	48.3
Concomitant Pulmonary infection		
None	43	74.1
Present	15	25.9
Malignancy		
None	50	86.2
Present	8	13.8
Treatment method		
Surgical	29	50.0
Tube thoracostomy	22	37.9
Pleural catheter	7	12.1
Pleural culture		
No growth	30	51.7
Monobacterial	22	37.9
Polymicrobial	6	10.3
Pleural fluid Gram stain*		
Gram negative	7	12.1
Gram positive	19	32.8
Gram-positive and Gram- negative	2	3.4
Total	58	100.0

*Gram staining was evaluated only in patients with positive pleural fluid culture (n=28)

Table 2 Median (Q1–Q3) and minimum–maximum values of patients' age and pleural fluid parameters

Parameter	Median (Q1- Q3)	Min-Max
Age (years)	57.0 (44.75-71.25)	21- 88
Length of Stay (days)	17.0 (11.0-21.2)	4-169
Pleural fluid WBC ×10³/µL	47.2 (6.0- 176.4)	1-496
Pleural fluid LDH IU/L	2042.5 (920.5- 5502.25)	77-41713
Pleural fluid glucose mg/dL	20.30 (4.25-41.31)	1-213

Table 3 Length of hospital stay by gender, chronic disease, concomitant pulmonary infection, and malignancy

Characteristic	n	Median Length of Hospital Stay (Q1-Q3)	p*
Gender			
Male	48	18.0 (11.2- 22.0)	0.132
Female	10	14.0 (9.2- 18.0)	
Chronic disease			
None	30	14.5 (9.0-21.2)	**0.025**
Present	28	18.5 (15.0-25.5)	
Concomitant Pulmonary infection			
None	43	18.0 (13.0-22.0)	0.111
Present	15	14.0 (9.0-18.0)	
Malignancy			
None	50	14.0 (5.7-17.2)	**0.038**
Present	8	17.5 (11.7- 22.0)	

*Mann-Whitney U test

Table 4 Length of hospital stay by treatment method and pleural fluid microbiological characteristics

Characteristic	n	Median Length of Hospital Stay (Q1-Q3)	p*
Treatment method			
Surgical	29	15.0 (11.0-19.5)	0.449
Tube thoracostomy	22	18.0 (15.0-23.2)	
Pleural catheter	7	20.0 (6.0-43.0)	
Pleural culture			
No growth	30	18.0 (10.5- 23.0)	0.530
Monobacterial	22	16.0 (14.0- 21.7)	
Polymicrobial	6	15.0 (9.2- 18.0)	
Pleural fluid Gram stain*			
Gram negative	7	18.0 (17.0- 28.0)	0.079
Gram positive	19	15.0 (11.0- 18.0)	
Gram positive and Gram negative	2	18.0 (15.0- 21.0)	

*Kruskal–Wallis test, +Gram staining in patients with growth in pleural fluid (n=28)

deemed necessary. Furthermore, VATS is performed in cases where empyema fluid cannot be drained using conventional thoracic drainage methods, and the patient's clinical condition worsens despite antibiotic therapy.

In empyema, infection of the pleural cavity by microorganisms causes a massive inflammatory cell migration into the pleural cavity. LDH, a glycolytic enzyme, can indicate the severity of the inflammatory response. In empyema, elevated levels of WBC and

Table 5 Correlation matrix of length of hospital stay, age, and pleural fluid parameters

		Length of Stay	Age	Pleural fluid WBC	Pleural fluid LDH	Pleural fluid glucose
Length of Stay	rho	1				
	p					
Age	rho	0.067	1			
	p	0.618				
Pleural fluid WBC ×10³/µL	rho	0.383	0.409	1		
	p	**0.007**	**0.004**			
Pleural fluid LDH IU/L	rho	0.240	0.125	0.491	1	
	p	0.075	0.357	**<0.001**		
Pleural fluid glucose mg/dL	rho	-0.166	-0.118	-0.251	-0.104	1
	p	0.238	0.403	0.096	0.469	

rho: Spearman's correlation coefficient

LDH in pleural fluid are typically expected (7). Many studies, including those by Soriano et al., Alegre et al., and Alemán et al., have reported that patients with higher WBC counts and LDH levels in pleural fluid samples had longer hospital stays (8-10). The results of this study support these findings, and it is expected that pleural fluid WBC and LDH levels will be high in patients requiring a higher inflammatory response and that this will correlate positively with the length of hospital stay.

Both malignancies and chronic diseases are known to have adverse effects on patients' immune systems (11, 12). Karandashova et al. and Liu et al. found that, in patients with empyema, the presence of comorbid chronic diseases or malignancy was associated with prolonged hospital stay and recurrent hospital admissions (13, 14). Among patients hospitalized for empyema at our clinic, those with chronic disease or cancer stayed in the hospital longer than other patients. The longer hospitalization period in patients with chronic disease and malignancy may be attributed to impaired immune function.

The microbiological yield in pleural empyema may be limited despite active infection. In the present study, more than half of the pleural fluid cultures showed no bacterial growth. One possible explanation for this finding is the initiation of empirical antibiotic therapy before pleural fluid sampling, which is common in patients presenting with severe pulmonary infections. Previous studies have similarly reported reduced microbiological isolation rates following prior antibiotic exposure (15). In addition, inadequate sample volume, delayed transport to the microbiology laboratory, and the presence of fastidious or anaerobic microorganisms may further contribute to culture negativity (16). Therefore, negative pleural culture results should not exclude the diagnosis of empyema when clinical, biochemical, and radiological findings are strongly suggestive of pleural infection.

In the present study, no significant association was observed between treatment modality and length of hospital stay. This finding may be related to the multifactorial nature of pleural empyema management, in which treatment decisions are influenced by disease stage, loculation, clinical status, and accompanying comorbidities (17). Although some reports have indicated shorter hospitalization durations with surgical management in selected patient groups, the available evidence remains heterogeneous (18). Therefore, treatment strategies in empyema management should be planned individually according to the clinical characteristics and overall condition of each patient (19).

One strength of this study is the combined evaluation of clinical, biochemical, microbiological, and treatment-related factors associated with hospital stay in patients with pleural empyema. In addition, the study reflects real-world clinical data from a tertiary referral center. The findings may contribute to a better understanding of factors associated with prolonged hospitalization in empyema management.

The limitations of this study include the exclusion of other treatment modalities for empyema, such as fibrinolytic therapy and open drainage, the relatively small sample size, and the retrospective design. Future prospective studies with larger sample groups comparing all treatment methods for empyema are needed.

In conclusion, pleural empyema remains a clinically important condition associated with prolonged hospitalization, particularly in patients with chronic disease, malignancy, and increased pleural inflammatory activity. Pleural fluid WBC levels were positively associated with hospital stay duration, whereas microbiological growth patterns and treatment modalities were not significantly associated with hospitalization length in this study population. These findings may help identify factors associated with prolonged hospitalization in patients with pleural empyema.

Conflict of Interest Statement
The authors have no conflicts of interest to declare.

Ethical Approval
The study was conducted following the approval (No: 107/31; dated 09.12.2025) of the Suleyman Demirel University Health Sciences Ethics Committee. The study was conducted in accordance with the ethical principles stated in the Declaration of Helsinki of the World Medical Association (WMA).

Consent to Participate and Publish
Written informed consent to participate and publish waived due to retrospective nature of the study.

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Availability of Data and Materials
Datasets generated and/or analyzed during the current study will be made available by the corresponding author upon request.

Artificial Intelligence Statement
The authors declare that they have not used any type of generative artificial intelligence for the writing of this manuscript, nor for the creation of images, graphics, tables, or their corresponding captions.

Authors Contributions
H.E.C and C.D: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Validation; Visualization; Writing-original draft.

H.E.Y and S.E.A: Investigation; Validation; Writing-original draft.

RY: Data curation; Formal analysis; Writing- review & editing.

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