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Prognostic Factors in Patients with Lung Cancer in the Intensive Care Unit: A Retrospective Single-Center Study

Suleyman Yildirim,[1] Ozcan Alpdogan,[2] Cenk Kirakli[1]

Abstract

Aim: Patients diagnosed with lung cancer may require intensive care due to sudden and severe clinical events; however, early survival outcomes vary widely. In this context, we investigated ICU mortality and analyzed admission-specific clinical characteristics associated with death in a healthcare setting where access to intensive care is not limited by predefined admission criteria.

Study Design: The study population consisted of adult individuals with lung cancer who required intensive care from 2018 to 2022. Patient demographics, cancer-related features, indications for ICU admission, illness severity indices, requirements for organ-supportive therapies, and clinical outcomes were systematically evaluated. Associations between baseline variables and ICU mortality were examined using multivariable logistic regression analysis.

Results: The study cohort comprised 351 critically ill patients with lung cancer. The median age was 66 years, and ICU mortality occurred in 76% of cases. The presence of metastatic disease independently increased the risk of death (OR 2.32, 95% CI 1.26–4.26). In contrast, patients admitted due to hypercapnic respiratory failure demonstrated a significantly lower mortality risk (OR 0.36, 95% CI 0.17–0.75). Higher illness severity scores were consistently associated with unfavorable outcomes.

Conclusions: Despite significant advances in intensive care medicine, short-term outcomes for lung cancer patients admitted to the ICU remain unfavorable. Disease burden, reflected by metastatic status and severity scores, strongly influences outcomes, whereas patients admitted with hypercapnic respiratory failure demonstrate a more favorable prognosis.

Keywords: Intensive care unit; Lung cancer; Mortality; Respiratory failure; SOFA score.

[1]*University of Health Sciences, Izmir Faculty of Medicine, Dr. Suat Seren Chest Disease and Thoracic Surgery Training and Research Hospital, Intensive Care Unit, Izmir, Türkiye*

[2]*Intensive Care Unit, University of Health Sciences, İzmir School of Medicine, Tepecik Training and Research Hospital, İzmir, Türkiye*

Address for correspondence:
Suleyman Yildirim, University of Health Sciences, Izmir Faculty of Medicine, Dr. Suat Seren Chest Disease and Thoracic Surgery Training and Research Hospital, Intensive Care Unit, Izmir, Türkiye.
E-mail: deu.syldrm@gmail.com

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Introduction

Lung cancer imposes a significant global health burden, with many patients eventually requiring intensive care due to life-threatening respiratory deterioration or complications arising from advanced disease.[1,2] Despite substantial progress in oncologic diagnostics and treatment strategies, many patients continue to develop severe, life-threatening conditions that necessitate intensive care support. These complications most commonly include respiratory failure, septic shock, and acute neurologic deterioration, all of which are associated with a high risk of short-term mortality.[3–6] With the increasing incidence of metastatic lung cancer and the complex-

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ity of its management, identifying factors linked to poor outcomes in ICU settings has become a critical focus for clinicians and researchers alike.

Advances in cancer treatment strategies over the past few decades have been accompanied by measurable improvements in survival among patients with solid malignancies.[7] Enhanced critical care and oncologic management have led to better ICU survival rates among cancer patients, with mortality rates for those with solid tumors now approaching those observed in patients without malignancy.[7,8] Nevertheless, individuals with lung cancer continue to experience poorer outcomes following ICU admission compared to patients with other solid malignancies.[9] ICU mortality has been reported as ranging from 28% to 47% in previous studies.[4–6,10] In some studies, mortality rates exceed 70%.[11,12] This high mortality rate highlights the importance of identifying prognostic factors that influence ICU outcomes in this population. Understanding variables such as metastatic disease, the severity of respiratory failure, and the need for early invasive interventions may help clinicians make timely and appropriate decisions regarding life-sustaining treatments.

A major unresolved issue in the care of critically ill cancer patients is the lack of standardized frameworks to guide ICU admission decisions in those with advanced disease. Intensivists and oncologists often approach these decisions from different clinical perspectives.[13] Earlier studies suggest that unfavorable ICU outcomes among cancer patients are influenced by factors such as patient age, the extent of acute physiological derangement, the need for ventilatory support, and the burden of organ failure at admission.[4–6,14,15] In Türkiye, ICU admission policies are relatively liberal, with no legal or institutional restrictions on life-sustaining therapies. Unlike in North America and Europe, where guidelines for end-of-life decisions and the limitation of futile treatments are well established, such practices are less clearly defined in Türkiye.[16,17] As a result, critically ill patients with advanced lung cancer are increasingly treated in intensive care settings, where prolonged life-sustaining interventions may be implemented despite limited anticipated benefit. The objective of this study was to investigate ICU mortality in lung cancer patients and identify clinical factors present at admission that are associated with mortality in a system without restrictions on ICU access.

Materials and Methods

This retrospective analysis was conducted in a respiratory disease-focused ICU with a capacity of 23 beds, serving as a tertiary referral center for patients with severe pulmonary disorders, including lung cancer. The study was approved by the University of Health Sciences Türkiye, Dr. Suat Seren Chest Disease and Thoracic Surgery Teaching and Research Hospital Clinical Research Ethics Committee (Approval Number: 2023/29-38, Date: 06.06.2023). Given the retrospective nature of the study and the use of anonymized data, the requirement for informed consent was waived.

Patients

Adult patients with a histopathological diagnosis of lung cancer who required intensive care during the study period were evaluated for inclusion. Patients were eligible if their ICU length of stay exceeded 24 hours and if all predefined clinical variables and outcome measures were available for analysis.

Patients who died within the first 24 hours, those admitted immediately following oncologic surgery, individuals with a lung cancer diagnosis exceeding five years, and cases with incomplete records were excluded. The flow of patient selection is presented in Figure 1. During the study period, pulmonologists referred patients from hospital wards or the emergency department when intensive care support was deemed necessary, and the attending intensivist determined eligibility for ICU admission. Ad-

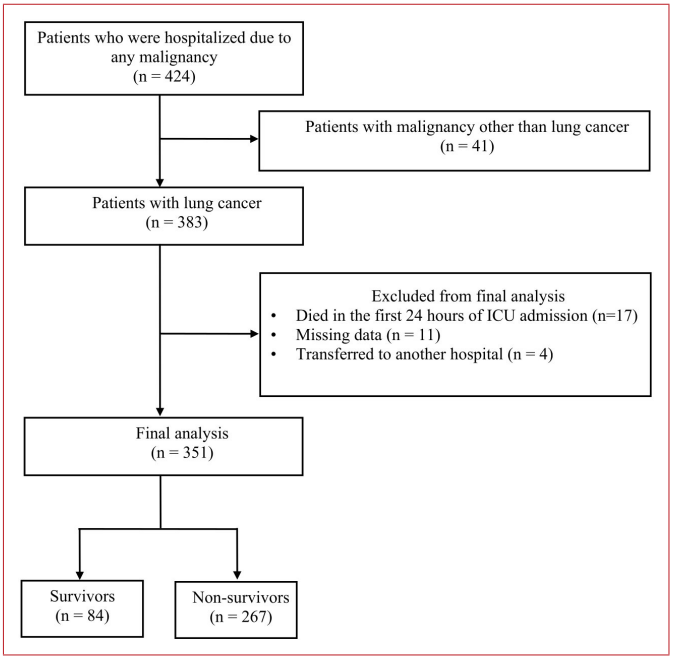

Figure 1. Flowchart of patient selection process.

mission was generally unrestricted, except in cases where the patient or their legal representative declined intensive care.

Data Collection

For each patient, demographic and clinical characteristics were obtained, including age, gender, comorbid conditions, histological subtype of lung cancer, presence of metastatic disease, prior chemotherapy or radiotherapy, and documented treatment response.

Additional variables included the primary reason for ICU admission, respiratory status at presentation, disease severity scores, as well as the requirement for vasopressor therapy and renal replacement therapy (RRT). ICU admission diagnoses were categorized into eight groups:

1. Hypoxemic respiratory failure ($PaO_2 < 60$ mmHg)
2. Hypercapnic respiratory failure ($PaCO_2 > 45$ mmHg)
3. Septic shock
4. Acute neurological impairment
5. Post–cardiopulmonary resuscitation (CPR)
6. Neutropenic fever
7. Hemoptysis
8. Acute kidney injury

Since "do not resuscitate" (DNR) or "do not intubate" (DNI) directives are not legally recognized in Türkiye, all cancer patients experiencing cardiac arrest received full basic and advanced life support. When multiple clinical problems were present at admission, the condition judged to be the predominant cause for ICU referral was recorded as the principal reason.

Statistical Analysis

Data analysis was performed using SPSS version 26.0 (IBM, Armonk, NY, USA). Continuous variables are summarized using median and interquartile range values, whereas categorical variables are described as absolute numbers and percentages. Comparisons between survivor and non-survivor groups were made using non-parametric statistical tests or chi-square analysis, as appropriate. To determine factors independently associated with ICU mortality, variables meeting a predefined threshold in univariable analysis ($p<0.20$) were incorporated into an adjusted logistic regression model. Results are presented as odds ratios with 95% confidence intervals, and statistical significance was defined as $p<0.05$.

Results

The analysis included 351 patients, with a median age of 66 years (IQR 59–71), and the majority of the cohort was male (309 patients, 88%). Among pre-existing conditions, hypertension was the most frequently observed comorbidity, followed by diabetes mellitus and chronic obstructive pulmonary disease, with prevalences of 25.4%, 22.8%, and 21.1%, respectively. Approximately half of the patients had metastatic disease; squamous cell carcinoma (42.2%) and adenocarcinoma (39.9%) were the most common histological types of lung cancer. Among the study population, 199 patients (56.7%) had not received chemotherapy at the time of ICU admission. This subgroup included newly diagnosed patients awaiting treatment initiation, patients with poor performance status who were not eligible for systemic therapy, and patients receiving only palliative or supportive care. The leading reason for ICU admission was hypoxemia (37.9%), followed by post-CPR (16.2%) and hypercapnia (15.7%). Detailed demographic information is presented in Table 1.

More than three-quarters of the patients (n=267, 76%) experienced mortality during their ICU stay. Survivors were more likely to be admitted for hypercapnic respiratory failure (38.1%) compared to non-survivors (8.6%) ($p<0.001$). Non-survivors were more frequently admitted for hypoxemic respiratory failure (40.4%) compared to survivors (29.8%) ($p<0.001$). The APACHE II scores were markedly higher in non-survivors (median 24, IQR 20–30) than in survivors (median 18, IQR 14–22) ($p<0.001$).

Ventilatory support requirements within the first 24 hours of ICU admission differed significantly according to survival status (Table 2). Non-invasive mechanical ventilation (NIMV) was more frequently used among survivors compared to non-survivors (50.0% vs. 23.6%, $p<0.001$). The use of invasive mechanical ventilation was significantly more frequent among patients who did not survive compared to survivors (67.0% vs. 29.8%, $p<0.001$). Similarly, vasopressor therapy was administered more often in non-survivors (39.7%) than in survivors (14.3%, $p<0.001$). These findings were consistent with greater organ dysfunction at ICU admission, as reflected by higher SOFA scores in non-survivors (median 5, IQR 3–8) compared to survivors (median 3, IQR 2–4; $p<0.001$) (Table 2).

After adjustment in the multivariable logistic regression model, metastatic cancer remained the dominant predictor of ICU mortality, increasing the odds of death by

Table 1. Demographic features of patients

Variable	All patients (n=351)	Survivors (n=84)	Non-survivors (n=267)	p
Age, median (IQR), years	66 (59–71)	66 (58–71)	66 (60–72)	0.577
Gender, male, n (%)	309 (88)	72 (85.7)	237 (88.8)	0.453
BMI, median (IQR), kg/m²	23.8 (21.2–26.2)	24.0 (20.8–27.6)	23.8 (21.3–26.0)	0.559
Smoking status, n (%)				
Non-smoker	12 (3.4)	7 (8.3)	5 (1.9)	0.655
Active smoker	107 (30.5)	24 (28.6)	83 (31.1)	
Ex-smoker	227 (64.7)	56 (66.7)	171 (64.0)	
Smoking duration, median (IQR), pack-years	45 (40–50)	40 (35–50)	45 (40–50)	0.750
Comorbid diseases, n (%)				
COPD	74 (21.1)	29 (34.5)	45 (16.8)	0.001
DM	80 (22.8)	26 (30.9)	54 (20.2)	0.041
Hypertension	89 (25.4)	25 (29.8)	64 (24.0)	0.287
CAD	45 (12.8)	13 (15.5)	32 (12.0)	0.404
CHF	23 (6.6)	7 (8.3)	16 (6.0)	0.450
Other malignancy	13 (3.7)	2 (2.4)	11 (4.1)	0.462
Number of comorbidities	1 (0–1)	0 (0–1)	1 (0–2)	0.014
Histological type, n (%)				
Small cell carcinoma	44 (12.5)	11 (13.1)	33 (12.4)	0.679
Squamous cell carcinoma	148 (42.2)	36 (42.9)	112 (41.9)	
Adenocarcinoma	140 (39.9)	35 (41.7)	105 (39.3)	
Other	19 (5.4)	2 (2.3)	17 (6.4)	
Metastasis status, n (%)				
Non-metastatic	180 (51.3)	60 (71.4)	120 (44.9)	<0.001
Metastatic	171 (48.7)	24 (28.6)	147 (55.1)	
Radiotherapy				
No radiotherapy	198 (56.4)	48 (57.1)	150 (56.2)	0.642
Thoracic	98 (27.9)	25 (29.8)	73 (27.3)	
Cranial	33 (9.4)	5 (6.0)	28 (10.5)	
Bone	22 (6.3)	6 (7.1)	16 (6.0)	
Chemotherapy				
No chemotherapy	199 (56.7)	46 (54.8)	153 (57.3)	0.709
Less than 1 month*	73 (20.8)	19 (22.6)	54 (20.2)	
1–3 months*	38 (10.8)	9 (10.7)	29 (10.9)	
8–12 months*	20 (5.7)	3 (3.6)	17 (6.4)	
More than 12 months*	21 (6.0)	7 (8.3)	14 (5.2)	
Response to treatment, n (%)				
No treatment evolution	237 (67.5)	47 (56.0)	190 (71.2)	<0.001
Progression	72 (20.5)	12 (14.3)	60 (22.5)	
Stable	33 (9.4)	19 (22.6)	14 (5.2)	
Regression	9 (2.6)	6 (7.1)	3 (1.1)	

BMI: Body Mass Index; CAD: Coronary Artery Disease; CHF: Chronic Heart Failure; COPD: Chronic Obstructive Pulmonary Disease; DM: Diabetes Mellitus; IQR: Interquartile Range; *Time interval between the last chemotherapy session and ICU admission.

Table 2. Clinical characteristics of patients

Variable	All patients (n=351)	Survivors (n=84)	Non-survivors (n=267)	p
Cause of ICU admission, n (%)				
Hypoxemia	133 (37.9)	25 (29.8)	108 (40.4)	<0.001
Hypercapnia	55 (15.7)	32 (38.1)	23 (8.6)	
Septic shock	32 (9.1)	6 (7.1)	26 (9.7)	
Neurologic disturbance	22 (6.3)	5 (6.0)	17 (6.4)	
Post-CPR	57 (16.2)	4 (4.8)	53 (19.9)	
Neutropenic fever	17 (4.8)	2 (2.4)	15 (5.6)	
Hemoptysis	14 (4.0)	4 (4.8)	10 (3.7)	
Acute kidney injury	21 (6.0)	6 (7.1)	15 (5.6)	
APACHE-2 score	23 (17–28)	18 (14–22)	24 (20–30)	<0.001
Respiratory status on 1st day of ICU, n (%)				
O^2 support only	42 (12.0)	17 (20.2)	25 (9.4)	<0.001
NIMV	105 (29.9)	42 (50.0)	63 (23.6)	
IMV	204 (58.1)	25 (29.8)	179 (67.0)	
Vasopressor use on 1st day of ICU, n (%)	118 (33.6)	12 (14.3)	106 (39.7)	<0.001
RRT on 1st day of ICU, n (%)	23 (6.6)	2 (2.4)	21 (7.9)	0.076
SOFA score on 1st day of ICU, median (IQR)	4 (3–7)	3 (2–4)	5 (3–8)	<0.001
LOS of ICU, median (IQR), days	8 (4–15)	7 (4–13)	8 (3–16)	0.994

APACHE: Acute Physiology and Chronic Health Evaluation; CPR: Cardiopulmonary Resuscitation; ICU: Intensive Care Unit; IMV: Invasive Mechanical Ventilation; IQR: Interquartile Range; LOS: Length of Stay; NIMV: Non-invasive Mechanical Ventilation; RRT: Renal Replacement Therapy; SOFA: Sequential Organ Failure Assessment

more than twofold (OR 2.32, 95% CI 1.26–4.26; p=0.007). Severity-of-illness scores also demonstrated independent prognostic value, with incremental increases in APACHE II and SOFA scores associated with a higher mortality risk (OR 1.09, 95% CI 1.03 – 1.16; p=0.002 and OR 1.21, 95% CI 1.03 – 1.42; p=0.024, respectively). Conversely, patients admitted with hypercapnic respiratory failure had a significantly reduced risk of ICU mortality (OR 0.36, 95% CI 0.17–0.75; p=0.006). Post-CPR status was not independently related to mortality in the adjusted model (Table 3).

Table 3. Multivariate analysis for ICU mortality

Variable	OR (95% CI)	p
Age	1.03 (0.99–1.06)	0.109
Number of comorbidities	1.04 (0.87–1.27)	0.445
Metastatic cancer	2.32 (1.26–4.26)	0.007
APACHE-2 score	1.09 (1.03–1.16)	0.002
SOFA score on the 1st day of ICU	1.21 (1.03–1.42)	0.024
Hypercapnic respiratory failure	0.36 (0.17–0.75)	0.006
Post-CPR	1.36 (0.42–4.42)	0.612

APACHE: Acute Physiology and Chronic Health Evaluation; CPR: Cardiopulmonary Resuscitation; ICU: Intensive Care Unit; OR: Odds Ratio; SOFA: Sequential Organ Failure Assessment.

Discussion

This investigation aimed to identify clinical determinants associated with ICU mortality in patients with lung cancer who required intensive care. Our analysis revealed a notably high mortality rate, reflecting the challenges inherent in treating critically ill individuals with advanced malignancy. The findings demonstrate that metastatic involvement, greater illness severity, and early organ dysfunction significantly contribute to adverse outcomes. These observations offer valuable insights that may assist clinicians in making informed decisions when managing lung cancer patients in the ICU.

The most striking finding of this study was the exceptionally high ICU mortality among lung cancer patients: three out of every four individuals did not survive their ICU stay, where end-of-life decisions and limitations of life-sustaining treatment are not routinely applied. Prior studies have consistently reported unfavorable outcomes

among lung cancer patients admitted to the ICU, although mortality rates vary considerably across different cohorts. Qian et al.[5] documented a 28-day mortality rate of 30.6% in a single-center cohort, while Puxty et al.[6] observed that 41.5% of lung cancer patients admitted to ICUs in a nationwide study died during their ICU stay. Earlier studies have reported even higher mortality rates—Boussat et al.[12] noted ICU mortality reaching 67.5% in the early 2000s. The ICU mortality observed in this cohort was notably higher than that reported in earlier studies, with only 23.9% of patients surviving to ICU discharge. The absence of established end-of-life decision-making processes may have substantially contributed to the elevated mortality rate observed in this population. Another notable characteristic of our population was the high proportion of post-cardiopulmonary resuscitation (post-CPR) admissions. Following hypoxemic respiratory failure, post-CPR status represented the second most frequent reason for ICU admission, accounting for 16.2% of the cohort—substantially higher than the rates reported in earlier studies (1.3% in Chen et al.,[3] 2% in Barth et al.,[4] and 7.3% in Puxty et al.[6]). Because DNR orders are not legally permitted in Türkiye, all patients, including those with advanced cancer, undergo full resuscitative efforts when cardiac arrest occurs. Outcomes for cancer patients after CPR are known to be poor. A meta-analysis reported that only 6.2% survived following CPR.[18] In our study, survival following CPR was similarly low, with only 4 of 57 post-CPR patients (7%) living beyond the event. The exclusion of postoperative patients—who are known to have lower mortality—may offer an additional explanation for the relatively high mortality rate observed in our study.[15]

In our cohort, metastatic disease at the time of ICU admission emerged as the strongest predictor of ICU mortality. Patients with metastasis had a 2.3-fold higher likelihood of dying in the ICU compared with those without metastatic involvement. This observation aligns with earlier work identifying metastasis as a major determinant of poor outcomes. Park et al.[15] demonstrated that cancer stage was the most influential clinical factor associated with ICU mortality among lung cancer patients, while Qian et al.[5] found that metastatic disease increased 28-day mortality risk by 1.7 times. The severity of acute illness also played a key role. Patients who did not survive had significantly higher APACHE II and SOFA scores upon admission compared to survivors. Similar findings have been noted across previous studies. Namendys-Silva et al.[19] reported that the APACHE II score independently predicted mortality with an odds ratio of 1.92, and Song et al.[20] showed that a SOFA score above 10 increased the risk of death nearly tenfold.

NIMV has been shown to confer important clinical benefits in patients with hypercapnic respiratory failure, notably by decreasing the need for invasive mechanical ventilation (IMV) and improving survival outcomes.[21] In contrast, IMV has repeatedly been reported as a strong predictor of mortality in patients with lung cancer.[4,5] Our results indicate that hypercapnic respiratory failure as the primary reason for ICU admission was associated with a lower risk of mortality, independent of other clinical factors. The relative reversibility of this condition and the applicability of noninvasive respiratory support may partly explain this favorable outcome.

Several limitations of this study should be considered. First, the retrospective design and the use of data from a single tertiary care center may limit the generalizability of the findings to other institutions and patient populations. Additionally, the use of electronic medical records and retrospective data collection restricted our ability to adjust for certain unrecorded confounders, including the timing of ICU referral and specific oncologic management decisions. Another limitation is the absence of follow-up information beyond the ICU stay; long-term outcomes, such as post-discharge quality of life, were not evaluated, although such data would provide important insight into the broader consequences of critical illness in this population. The study lacked detailed information on cancer-directed therapies—such as chemotherapy, immunotherapy, or targeted treatments—which may have influenced both the severity of illness at admission and overall survival in the ICU. Finally, standardized performance status or frailty measures (e.g., ECOG, Karnofsky, or clinical frailty scale) were not consistently available due to the retrospective design and therefore could not be analyzed, which may have influenced the interpretation of outcomes.

Conclusion

Our study highlights the high mortality rate among ICU patients with lung cancer, with metastatic disease and disease severity serving as significant prognostic factors. Early recognition of these factors and careful consideration of the potential benefits and limitations of ICU interventions are crucial for optimizing patient care.

Ethics Committee Approval: Ethics committee approval was

obtained from University of Health Sciences, Dr. Suat Seren Chest Disease and Thoracic Surgery Teaching and Research Hospital Clinical Research Ethics Committee (Approval Number: 2023/29-38, Date: 06.06.2023).

Informed Consent: Given the retrospective nature of the study and the use of anonymized data, the requirement for informed consent was waived.

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

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