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Length of stay in intensive care unit and factors associated with clinical outcomes in patients with postoperative intracranial masses

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ABSTRACT

Aims: This study aimed to evaluate factors associated with intensive care unit (ICU) length of stay (LOS) and mortality in patients who underwent surgical intervention for postoperative intracranial masses and required ICU monitoring.

Methods: This retrospective, single-center observational study included adult patients who underwent intracranial mass surgery and were followed in the ICU for at least 48 hours between January 2017 and December 2025. Demographic characteristics, comorbidities, tumor-related variables, clinical scores (Glasgow Coma Scale and APACHE II), need for and duration of mechanical ventilation, ICU complications, LOS, and mortality were recorded. Prolonged ICU stay was defined as >3 days. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of prolonged ICU stay.

Results: A total of 128 patients were included. The median ICU LOS was 3 days, and ICU mortality was 25.8%. Mechanical ventilation requirement, ventilation duration, respiratory complications, and higher APACHE II scores were significantly associated with both ICU LOS and mortality. In multivariate analysis, the APACHE II score was the only independent predictor of prolonged ICU stay (OR: 0.924, 95% CI: 0.862–0.991; p=0.027). Tumor type showed an association with ICU LOS in univariate analyses, whereas tumor location was not independently associated with outcomes.

Conclusion: In patients with postoperative intracranial masses, ICU LOS and mortality are primarily influenced by acute clinical severity and systemic complications rather than tumor characteristics. The APACHE II score is an independent predictor of prolonged ICU stay, highlighting the importance of early risk stratification to optimize ICU resource utilization.

Keywords: Intensive care unit, intracranial mass, length of stay, APACHE II, mortality

INTRODUCTION

Intracranial masses constitute a heterogeneous group of conditions, including primary brain tumors, metastatic lesions, vascular pathologies, and other space-occupying intracranial disorders.[1] These lesions may cause serious clinical manifestations, such as increased intracranial pressure, focal neurological deficits, and altered consciousness, frequently necessitating surgical intervention.[2] After surgery, a subset of patients requires admission to the intensive care unit (ICU) for close hemodynamic and neurological monitoring.[3]

Early identification of postoperative complications—including intracranial hemorrhage, cerebral edema, ischemic events, seizures, and hydrocephalus—is critical in this patient population.[4] Factors such as neurological deterioration, the need for mechanical ventilation, hemodynamic instability, infectious complications, and metabolic disturbances pose major challenges that may prolong the ICU course.[5] In this context, ICU length of stay (LOS) is considered a key indicator of both patient prognosis and efficient use of healthcare resources.[5,6]

The duration of hospitalization after craniotomy and tumor resection has been shown to be influenced by multiple factors, including patient-related characteristics (age, comorbidities, frailty, and preoperative neurological deficits), surgical and anesthetic variables (operative duration, intraoperative blood loss and transfusion requirements), and postoperative complications such as prolonged mechanical ventilation, infections, and thromboembolic events.[7,8]

Extended stays in intensive care are associated with increased risk of complications, higher mortality rates, and a greater cost burden on the healthcare system.[9] Therefore, identifying the factors that determine the LOS in intensive care and clinical outcomes in patients with postoperative intracranial masses is important for optimizing patient management.[10] Although studies exist on this patient group, those that focus on intensive care and examine clinical outcome-related factors in detail are limited.[11]

This study aimed to retrospectively evaluate factors associated with intensive care LOS and mortality in patients who underwent surgical intervention for an intracranial mass and were monitored in intensive care during the postoperative period.

METHODS

Ethics

After obtaining ethical approval from the Fırat University Non-interventional Researches Ethics Committee (Date: 05.01.2026, Decision No: E-50716828-020-755356), patient data were analyzed retrospectively. Our study was conducted in accordance with the Helsinki Declarations and the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines.

Study Design and Setting

This retrospective, observational, single-center study included patients with postoperative intracranial tumors who were followed in the third-level intensive care unit of Fırat University Hospital between January 2017 and December 31, 2025.

Owing to the study's retrospective nature, informed consent was waived.

Patient Selection and Inclusion Criteria

All patients who underwent intracranial tumor surgery within the specified time period and were monitored in the ICU for at least 48 hours postoperatively were included in the study. The inclusion criteria were as follows:

- Surgical intervention due to an intracranial mass
- Postoperative admission to the ICU

Patients with an ICU stay of less than 48 hours were excluded because early discharge or brief observation was deemed inadequate to capture the clinical course. Additionally, pregnant patients and those with incomplete clinical data that would not permit evaluation of the primary endpoints were excluded from the study. The study included only the initial postoperative ICU admission.

Patients were divided into two groups according to the median ICU LOS of the study population. Patients with an ICU stay of ≤3 days were classified as the short ICU stay group, whereas those with an ICU stay of >3 days were classified as the prolonged ICU stay group. All comparative and regression analyses were performed based on this grouping.

Data Collection

The data was obtained retrospectively utilizing the hospital information management system (HIMS), the intensive care patient monitoring system, and patient medical records. Demographic characteristics (age, sex, and comorbidities), diagnosis, type and location of the intracranial mass, tumor size, Glasgow Coma Scale (GCS) score, APACHE II score, requirement for and duration of mechanical ventilation, LOS in the ICU, complications (neurological, hemodynamic, respiratory, hemorrhagic, and metabolic), ICU mortality, and patient outcomes at ICU discharge (transfer to the ward, discharge, or death) were retrospectively collected from patient medical records and the hospital information system.

Study Endpoints

The primary endpoint of this study was prolonged ICU stay, defined as an ICU LOS exceeding 3 days.

Secondary endpoints included ICU mortality, need for mechanical ventilation, duration of mechanical ventilation, and complications developing during the ICU stay.

Statistical Analysis

The collected data were analyzed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Kolmogorov–Smirnov test. Variables with normal distribution were presented as mean±standard deviation. For non-normally distributed continuous variables, data are presented as median and interquartile range (IQR), defined as the 25^{th}–75^{th} percentiles. Categorical variables were expressed as counts and percentages. Prolonged ICU stay was defined as an ICU LOS exceeding the median value of the study population (>3 days). Multivariate logistic regression was performed to identify independent risk factors for a prolonged ICU stay (>3 days). Variables with $p < 0.10$ in univariate analyses were included in the multivariate model. Multicollinearity among variables included in the multivariable model was assessed using the variance inflation factor (VIF), and variables with a VIF>5 were considered indicative of problematic multicollinearity. Results were reported as odds ratios (OR) and 95% confidence intervals (CI). $p<0.05$ was accepted as statistically significant.

RESULTS

Patient Characteristics

A total of 128 postoperative patients with intracranial masses were included in the study. Patients were divided into two groups according to the median ICU LOS: ≤3 days (n=59) and >3 days (n=69). The overall mean age was 50.78±17.50 years. Patients with prolonged ICU stay were significantly older than those with shorter ICU stay (53.72±16.60 vs. 47.35±18.04 years, p=0.040). Sex distribution did not differ significantly between the two groups (p=0.302).

The mean GCS score was lower in patients with prolonged ICU stays than in those with shorter ICU stays (6.91±4.50 vs. 8.57±4.56), although this difference did not reach statistical significance (p=0.087). In contrast, the APACHE II score was significantly higher in the prolonged ICU stay group (18.81±8.87 vs. 12.77±6.27, p<0.001). Tumor type was significantly associated with ICU LOS (p=0.004). Prolonged ICU stay was more frequent among patients with glioblastoma/oligodendroglioma and metastatic tumors compared with other tumor types. Tumor location was not significantly associated with ICU LOS (p=0.744). Preoperative neurological deficits were significantly more common in patients with prolonged ICU stay (71.0% vs. 44.1%, p=0.002). The Charlson Comorbidity Index, expressed as median [IQR], did not differ significantly between groups (p=0.062). Intraoperative vasopressor use was significantly more frequent in patients with prolonged ICU stay (37.7% vs. 6.8%, p<0.001). Detailed demographic and clinical characteristics are presented in Table 1.

Complications Observed During ICU Follow-up

Complications observed during ICU follow-up were significantly more frequent in patients with prolonged ICU stay. Neurological deficits were observed in 56.5% of patients with ICU LOS >3 days compared to 15.3% in those with ICU LOS ≤3 days (p<0.001). Similarly, seizures (39.1% vs. 1.7%), arrhythmias (60.9% vs. 18.6%), respiratory complications (63.8% vs. 8.5%), metabolic complications (47.8% vs. 6.8%), and hemorrhagic complications (27.5% vs. 5.1%) were all significantly more common in the prolonged ICU stay group (all p<0.001). These findings are summarized in Table 2.

Clinical Outcomes

Mechanical ventilation was required in 72 patients (56.3%) overall and was significantly more common among patients with prolonged ICU stay (71.0% vs. 39.0%, p<0.001). The duration of mechanical ventilation was also significantly longer in patients with prolonged ICU stay (median 7 [1–110] days vs. 1 [1–2] days, p<0.001). ICU mortality occurred in 33 patients (25.8%) and was markedly higher in the prolonged ICU stay group compared to the short stay group (42.0% vs. 6.8%, p<0.001). Correspondingly, survival at ICU discharge was significantly lower among patients with ICU LOS >3 days (58.0% vs. 93.2%, p<0.001). Clinical outcomes according to ICU LOS are presented in Table 3.

Table 3. Clinical outcomes according to ICU length of stay

Outcome	Total (n=128)	ICU LOS ≤3 days	ICU LOS >3 days	p value
Mechanical ventilation (yes)	72 (56.3%)	23 (39.0%)	49 (71.0%)	<0.001
Duration of mechanical ventilation (days)	1 (1–110)	1 (1–2)	7 (1–110)	<0.001
ICU length of stay (days)	3 (1–110)	2 (1–2)	9 (3–110)	<0.001
ICU mortality	33 (25.8%)	4 (6.8%)	29 (42.0%)	<0.001
Discharge status (alive)	95 (74.2%)	55 (93.2%)	40 (58.0%)	<0.001

ICU: Intensive care unit, LOS: Length of stay

Table 1. Demographic and clinical characteristics according to ICU length of stay

Variable	Total (n=128)	ICU LOS ≤3 days (n=59)	ICU LOS >3 days (n=69)	p value
Age (years)	50.78±17.50	47.35±18.04	53.72±16.60	0.040
Sex (female/male)	63/65	31/28	32/37	0.302
Glasgow Coma Scale	7.67±4.58	8.57±4.56	6.91±4.50	0.087
Tumour type:				0.004
Metastasis	8 (6.2%)	3 (4.0%)	5 (9.2%)	
Glioblastoma/ oligodendroglioma	41 (32.0%)	17 (22.9%)	24 (44.4%)	
Meningioma	45 (35.2%)	30 (40.5%)	15 (27.7%)	
Schwannoma/ acoustic neuroma	4 (3.1%)	1 (1.3%)	4 (7.4%)	
Other	30 (23.4%)	24 (32.4%)	6 (11.1%)	
Tumour location:				0.744
Supratentorial	97 (75.8%)	58 (77.3%)	39 (73.6%)	
Posterior fossa	17 (13.3%)	8 (10.7%)	9 (17.0%)	
Ventricular	9 (7.0%)	6 (8.0%)	3 (5.7%)	
Brainstem	5 (3.9%)	3 (4.0%)	2 (3.8%)	
Preoperative neurological deficit (yes)	75 (58.6%)	26 (44.1%)	49 (71.0%)	0.002
Charlson Comorbidity Index	2 (0–6)	1 (0–5)	2 (0–6)	0.062
APACHE II score	16.03±8.32	12.77±6.27	18.81±8.87	<0.001

ICU: Intensive care unit, LOS: Length of stay, APACHE II: Acute Physiology and Chronic Health Evaluation II

Table 2. ICU-related complications according to ICU length of stay

Complication	Total (n=128)	ICU LOS ≤3 days	ICU LOS >3 days	p value
Ventriculoperitoneal shunt	31 (24.2%)	4 (6.8%)	26 (37.7%)	<0.001
Neurological deficit	48 (37.5%)	9 (15.3%)	39 (56.5%)	<0.001
Seizures	28 (21.9%)	1 (1.7%)	27 (39.1%)	<0.001
Arrhythmia	53 (41.4%)	11 (18.6%)	42 (60.9%)	<0.001
Respiratory complications	49 (38.3%)	5 (8.5%)	44 (63.8%)	<0.001
Metabolic complications	37 (28.9%)	4 (6.8%)	33 (47.8%)	<0.001
Hemorrhage	22 (17.2%)	3 (5.1%)	19 (27.5%)	<0.001

ICU: Intensive care unit, LOS: Length of stay

Factors Associated with Prolonged ICU Length of Stay

In univariate analyses, APACHE II score, respiratory complications, mechanical ventilation requirement, and duration of mechanical ventilation were significantly associated with prolonged ICU stay. In the multivariable logistic regression analysis, the APACHE II score was the independent predictor of prolonged ICU stay (OR 0.924, 95% CI 0.862–0.991; p=0.027). In addition, respiratory complications (OR 0.109, 95% CI 0.029–0.408; p=0.001) and duration of mechanical ventilation (OR 0.307, 95% CI 0.151–0.625; p=0.001) remained significantly associated with ICU LOS in the multivariable model. Other variables, including age, sex, tumor characteristics, Charlson Comorbidity Index, and intraoperative vasopressor use, were not independently associated with prolonged ICU stay. Detailed univariate and multivariable regression results are shown in Table 4.

DISCUSSION

This retrospective, single-center study evaluated factors associated with ICU LOS and mortality in postoperative patients with intracranial tumors. The main findings indicate that the APACHE II score is an independent predictor of prolonged ICU stay. The need for mechanical ventilation, its duration, and respiratory complications also significantly affected both mortality and the LOS. In contrast, age, gender, and the tumor's anatomical characteristics (type and location) were not significantly associated with these outcomes.

Prolonged ICU stays are associated not only with increased mortality and complication risks but also with a significant cost burden on the healthcare system. This underscores that prolonged hospital stays are a critical issue, both clinically and economically, in centers with limited intensive care resources. Moitra et al.[9] demonstrated that hospital stays exceeding seven days in intensive care account for a significant proportion of total bed days and that this patient group also incurs higher costs for long-term care, rehabilitation, and readmissions. When these data are considered alongside our finding that prolonged ICU stays are associated with mortality, it suggests that the LOS in intensive care should be regarded as both a clinical and economic quality indicator.

In our study, the finding that the APACHE II score was independently associated with prolonged ICU stay suggests that ICU duration is influenced not only by surgical or tumor-related factors but also by indicators of acute physiologic deterioration and overall systemic disease severity. In line with this, Decavèle et al.[14] reported that mortality among patients admitted to intensive care for primary malignant brain tumors was primarily determined by indicators of acute clinical severity, including the need for mechanical ventilation, respiratory parameters, and the GCS. Moreover, the strong association observed between mechanical ventilation requirements and the duration of ventilation with mortality in our cohort is consistent with previous neurointensive care studies, which have identified mechanical ventilation as one of the most powerful predictors of poor prognosis. Collectively, these findings suggest that mechanical ventilation represents not merely a supportive intervention but also a surrogate marker of a high-risk clinical phenotype in postoperative intracranial tumor patients.

Our study found that respiratory complications were associated with both prolonged ICU stays and mortality, highlighting the importance of systemic complications in patients with postoperative intracranial tumors. de Almeida et al.[11] reported that respiratory failure and seizures were among the most common reasons for requiring transfer to intensive care in patients following elective intracranial surgery. These complications in the early postoperative period have been identified as key factors prolonging intensive care and worsening prognosis. Our findings are consistent with these reports in the literature.

Table 4. Univariate and multivariate logistic regression analysis of factors associated with length of stay

Variable	Univariate p	Multivariate B	Multivariate OR	95% CI for OR	Multivariate p
Age (years)	0.318	-0.012	0.988	0.962–1.015	0.375
Sex (male/female)	0.269	-0.467	0.627	0.272–1.448	0.275
Glasgow Coma Scale	0.929	-0.003	0.997	0.886–1.121	0.958
Tumor type	0.066	0.115	1.122	0.989–1.271	0.073
Tumor localization	0.332	-0.033	0.967	0.910–1.029	0.290
Preoperative neurological deficit	0.158	-0.647	0.524	0.226–1.213	0.131
Charlson Comorbidity Index	0.144	-0.248	0.781	0.570–1.069	0.123
APACHE score	0.024	-0.079	0.924	0.862–0.991	0.027
Ventriculoperitoneal shunt	0.677	0.083	1.086	0.190–6.198	0.926
Neurological deficit	0.583	-0.248	0.780	0.230–2.640	0.690
Seizure	0.116	-2.209	0.110	0.010–1.146	0.065
Arrhythmia	0.229	-0.676	0.509	0.143–1.805	0.296
Respiratory complication	<0.001	-2.212	0.109	0.029–0.408	0.001
Metabolic complication	0.421	0.528	1.696	0.269–10.674	0.574
Hemorrhage	0.595	-0.622	0.537	0.096–2.996	0.478
Mechanical ventilation	0.015	0.005	1.005	0.382–2.644	0.992
Duration of mechanical ventilation	<0.001	-1.180	0.307	0.151–0.625	0.001

OR: Odds ratio, CI: Confidence interval, APACHE: Acute Physiology and Chronic Health Evaluation

The association between prolonged ICU stay and poor clinical outcomes is not unique to neurosurgical patients. Although our study did not evaluate long-term mortality, the finding that prolonged ICU stay is associated with mortality is consistent with the general intensive care literature and suggests that ICU LOS may be a strong prognostic indicator.

An increasing number of studies suggest that it may not always be necessary to routinely admit all patients to intensive care after elective intracranial tumor surgery. Phillips et al.[6] reported that prolonged hospital stays after craniotomy are largely attributable to modifiable processes (delays in postoperative imaging, rehabilitation, and discharge planning) and that the LOS can be reduced through appropriate patient selection. This approach, when considered alongside our finding that prolonged ICU stays are associated with specific clinical risk profiles, suggests that intensive care resources could be used more rationally in selected patient groups.

On the other hand, the importance of preoperative physiological reserve is increasingly emphasized. Thommen et al.[7] demonstrated in their large multicenter analysis that frailty is a strong independent predictor of mortality, complications, and prolonged hospital stay after craniotomy, independent of age. Although we did not use the frailty score directly in our study, the association of scores reflecting acute illness severity, such as APACHE II, with prolonged ICU stay supports the notion that the concept of physiological reserve plays a decisive role in intensive care outcomes.

Tumor type was associated with ICU LOS in the univariate analysis; however, this association did not persist after adjustment for clinical severity parameters, indicating that physiological derangement and postoperative course may outweigh tumor-related characteristics in determining ICU outcomes. Consistent with this, Decavèle et al.[14] reported that intensive care mortality is more closely associated with the reason for ICU admission and the life-support therapies administered than with tumor type.

Limitations

This study has certain limitations. The retrospective, single-center design is subject to selection bias and limited in its ability to establish causal relationships. Furthermore, the inability to include tumor resection grade, intraoperative hemodynamic variables, and detailed histopathologic data in the analysis limited the evaluation of certain factors that could influence intensive care duration and mortality. However, the patient population spanning a long time period and the detailed intensive care data are among the study's strengths.

CONCLUSION

As a result, the APACHE II score is an independent predictor of prolonged ICU stay in patients with postoperative intracranial tumors. The need for mechanical ventilation, ventilation duration, and respiratory complications significantly affect both LOS and mortality. When considered alongside the literature, these findings provide clinical clues that could help identify high-risk patients early and use intensive care resources more cost-effectively and selectively.

ETHICAL DECLARATIONS

Ethics Committee Approval

Ethical approval for this study was obtained from the Non-interventional Researches Ethics Committee of Fırat University (Date: 05.01.2026, Decision No: E-50716828-020-755356).

Informed Consent

As this was a retrospective study, formal written informed consent was not required and was therefore not obtained.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

The author confirms sole responsibility for the study conception, design, data collection, analysis, interpretation, and manuscript preparation. All aspects of the work were carried out by the author.

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