ORIGINAL ARTICLE

PREDICTORS OF ICU MORTALITY AND SURVIVOR LENGTH OF STAY AMONG CRITICALLY ILL OLDER ADULTS: A SIX-YEAR COHORT STUDY

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Abstract

Introduction: As the number of older patients admitted to intensive care units (ICUs) increases, distinguishing predictors of mortality from determinants of recovery is increasingly relevant. The primary aim of this study was to identify predictors of ICU mortality, and the secondary aim was to evaluate factors associated with ICU length of stay among survivors.

Materials and Method: This retrospective cohort study included 2,029 patients aged ≥65 years admitted to the ICUs of a tertiary hospital from January 2020 to December 2025. ICU mortality was assessed using multivariable Cox regression, and ICU length of stay among survivors was analyzed using multivariable linear regression. Age, sex, ICU level, APACHE II score, Charlson Comorbidity Index, coronavirus disease 2019 (COVID-19) status, and admission diagnosis were included as covariates.

Results: The median age was 78 years (quartiles 1–3, 72–86), and ICU mortality was 37.3%. Older age (hazard ratio [HR]: 1.015 per year; $p = 0.002$), male sex (HR: 1.160; $p = 0.049$), a level 3 ICU admission (HR: 1.579; $p = 0.015$), a higher APACHE II score (HR: 1.066 per point; $p < 0.001$), and sepsis as the primary admission diagnosis (HR: 2.307; $p < 0.001$) were independently associated with mortality. Among survivors, a higher Charlson Comorbidity Index ($p < 0.001$), COVID-19 positivity ($p < 0.001$), and admission diagnosis (overall $p < 0.001$) were independently associated with a prolonged ICU stay.

Conclusion: Among critically ill older adults, short-term ICU survival was primarily associated with acute illness severity, whereas a prolonged ICU stay among survivors was more strongly associated with pre-existing comorbidity burden.

Keywords: Intensive Care Units; Aged; Mortality; Length of Stay; Severity of Illness Index; Comorbidity.

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INTRODUCTION

The steady rise in life expectancy is changing the age structure of societies worldwide, creating new realities for healthcare systems (1). By 2050, the number of individuals aged 65 years and older is projected to double, reaching approximately 2.1 billion worldwide (2). This demographic shift is increasingly observed in intensive care units (ICUs), where geriatric patients represent a substantial and growing proportion of admissions and often present with reduced physiological reserve (3). These patients pose a unique clinical challenge, characterized by homeostenosis—a state of diminished adaptive capacity in which even minor acute stressors can lead to catastrophic organ failure and adversely affect both survival and recovery following acute illness (4).

Even with continued strengthening of critical care infrastructure, ongoing pressure on ICU capacity highlights the need to distinguish between factors that determine survival and those that shape the recovery duration in older adults, particularly to optimize prognostic assessment and resource allocation (5, 6). In routine clinical practice, standardized scoring systems are commonly used to assess the likelihood of mortality and the expected course of recovery. The Acute Physiology and Chronic Health Evaluation II (APACHE II) scoring system remains one of the most widely validated and extensively used severity scoring systems to estimate mortality risk (7, 8). Nevertheless, such tools may not adequately explain factors associated with recovery duration (9). In that regard, the burden of pre-existing chronic conditions, quantified by the Charlson Comorbidity Index (CCI), has been associated with long-term functional outcomes following critical illness (10). Moreover, experiences during the coronavirus disease 2019 (COVID-19) pandemic revealed a distinct pattern of prolonged ICU stays, characterized by survivors requiring sustained organ support and substantial proportions of ICU resources, often independent of their initial severity scores, further underscoring the importance of distinguishing predictors of survival from determinants of prolonged recovery (11).

The extent to which acute disease severity and chronic comorbid conditions independently influence distinct clinical endpoints is not well established. Moreover, in several studies, short-term mortality and indicators of resource utilization, such as the ICU length of stay (LOS), have been analyzed concurrently, and in some instances, the LOS has been included in mortality models, potentially introducing a temporal overlap between predictors and outcomes (12). The abovementioned distinction is also critical for institutional planning, as survivors with prolonged stays, often termed "chronically critically ill patients," disproportionately utilize ICU resources (13). To our knowledge, few large-scale investigations have been conducted to evaluate these distinct clinical endpoints within a single cohort over an extended period that encompassed both the peak of the COVID-19 pandemic and the subsequent recovery phase of the healthcare system.

Accordingly, the primary aim of this study was to identify independent predictors of ICU mortality in critically ill older adults. As a secondary objective, we investigated determinants of the ICU LOS among survivors to differentiate predictors of survival from determinants of the recovery duration.

MATERIALS AND METHOD

This retrospective cohort study was conducted in the level 2 and 3 ICUs of a tertiary care hospital. All consecutive ICU admissions of patients aged ≥65 years between January 1, 2020, and December 31, 2025, were identified using the institutional electronic health record system. The study protocol was approved by the institutional ethics committee (approval number: 01.12.2025-E296315774/74). The requirement for informed consent was waived owing to the retrospective nature of the study and the use of anonymized data. All procedures were conducted in accordance with the Declaration of

Helsinki. Patients transferred from the ICU within 24 h, readmissions, and patients with missing data were excluded.

The primary outcome was ICU mortality, defined as death occurring during the ICU stay. This endpoint was prioritized to specifically evaluate factors influencing survival during the immediate acute phase of critical illness and to provide a consistent metric for ICU resource utilization analysis. The secondary outcome was the ICU LOS among survivors, defined as the number of days from ICU admission to ICU discharge, as recorded in the institutional health records. The ICU LOS was analyzed exclusively among survivors, as death during an ICU stay constitutes a competing event that artificially shortens the LOS, thereby confounding the interpretation of recovery-related determinants.

We analyzed the following demographic and clinical variables: age, sex, ICU level (2 vs. 3), primary diagnosis related to the ICU admission, APACHE II score at ICU admission (7), CCI (14), and COVID-19 status. Allocation to the level 2 or 3 ICU was determined according to institutional triage protocols based on the patient's initial requirement for invasive mechanical ventilation, vasopressor therapy, or advanced organ support. The APACHE II score is routinely calculated at ICU admission in our institution and was used as a standardized measure of acute illness severity (7).

CCI scores were calculated using International Classification of Diseases, Tenth Revision (ICD-10) diagnostic codes. Comorbid conditions were identified according to the validated ICD-10 Charlson comorbidity algorithm described by Quan et al. (15), and weighted scores were summed to obtain the total CCI. All recorded diagnostic codes were included in the comorbidity assessment, not only that of the primary diagnosis. The CCI was categorized as 0 (none), 1 (low), or ≥2 (high).

The primary diagnoses related to the ICU admission were categorized into mutually exclusive predefined groups (sepsis, respiratory, neurological, cardiovascular, postoperative/trauma, and others) based on ICD-10 codes recorded in the electronic health record system. COVID-19 positivity was defined as the presence of ICD-10 codes U07.1 or U07.2 documented in the electronic health record at ICU admission.

Statistical Analysis

Continuous variables are expressed as medians and quartiles 1–3 because they were non-normally distributed upon visual inspection of histograms, while categorical variables are presented as counts and percentages. Between-group comparisons (survivors vs. non-survivors) were performed using the Mann–Whitney U test for continuous variables and the chi-square test for categorical variables. All tests were two-sided, and a p-value < 0.05 was considered statistically significant. All analyses were conducted using IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, NY, USA).

The association between baseline variables and ICU mortality was evaluated using a multivariable Cox proportional-hazards regression model. This approach was preferred over logistic regression because ICU mortality represents a time-to-event outcome with variable follow-up duration and censoring at ICU discharge, thereby allowing the incorporation of survival time information and requiring appropriate handling of censored observations. Age, sex, ICU level, APACHE II score, CCI, COVID-19 status, and primary diagnosis related to the ICU admission were included in the model. The latter was entered into the model as a categorical variable, with postoperative/trauma as the reference category. Hazard ratios (HRs) with 95% confidence intervals (CIs) were reported. The proportional-hazards assumption was assessed using log-minus-log survival plots and was deemed satisfied.

For Kaplan–Meier survival curves, APACHE II scores were categorized into tertiles based on

its distribution in the study cohort for graphical presentation (16); in regression analyses, the APACHE II score was analyzed as a continuous variable. Survival time was defined as the interval from ICU admission to death of any cause during the ICU stay, and patients discharged alive were censored at the time of ICU discharge. Group differences were assessed using the log-rank test.

Predictors of the ICU LOS among survivors were assessed using multivariable linear regression analysis. Owing to right-skewness, the ICU LOS was log-transformed prior to analysis (17). Age, sex, ICU level, APACHE II score, CCI, COVID-19 status, and primary diagnosis related to the ICU admission were entered into the model simultaneously. The latter was entered as a categorical variable, with postoperative/trauma as the reference category. Beta (β) coefficients with 95% CIs were reported and represent the change in the log-transformed ICU LOS associated with a one-unit increase in the predictor.

RESULTS

In total, 2,029 older patients (median age: 78.0 years [quartiles 1–3: 72.0–86.0]) were included in the final analysis (Figure 1). Of these, 1,008 (49.7%) were male. During a median ICU follow-up of 8 days (quartiles 1–3: 3–16), 757 patients (37.3%) died, whereas 1,272 patients (62.7%) were discharged alive and censored at that time. The median follow-up time was 13 days (quartiles 1–3: 7–24) among non-survivors and 5 days (quartiles 1–3: 3–12) among survivors.

Regarding respiratory support at ICU admission, 1,019 (50.2%) patients required invasive mechanical ventilation and 853 (42.0%) required non-invasive ventilation. The remaining 157 patients (7.8%) received supplemental oxygen therapy via a simple face mask or nasal cannula without the need for ventilatory support. Notably, all patients who died during the follow-up period had received invasive mechanical ventilation at some point during their clinical course.

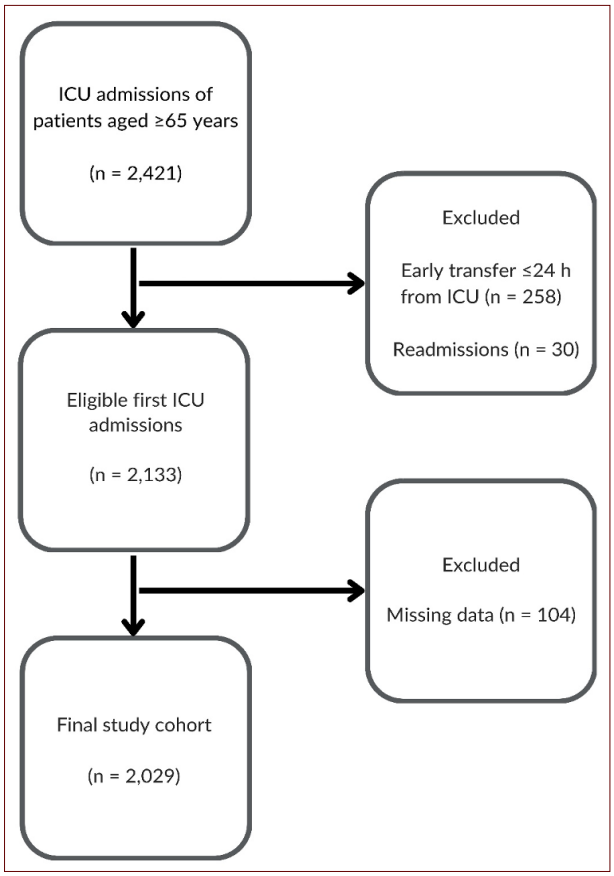


Figure 1. Study flow diagram

ICU = intensive care unit.

Non-survivors were significantly older than survivors (median: 79.0 vs. 77.0 years, $p < 0.001$) and were more frequently male (53.2% vs. 47.6%, $p = 0.013$). APACHE II scores were markedly higher among non-survivors (median: 37 [quartiles 1–3: 31–44]) than those among survivors (median: 18 [quartiles 1–3: 12–24], $p < 0.001$). COVID-19 positivity was also more common among non-survivors (18.9% vs. 7.6%, $p < 0.001$). Regarding the comorbidity burden, higher CCI categories were more prevalent among non-survivors ($p = 0.031$). Admission to a level 3 ICU was more common among non-survivors (96.0% vs. 84.5%, $p < 0.001$) (Table 1).

The primary diagnosis associated with the ICU admission differed between survivors and non-

Table 1. Baseline Characteristics of the Study Sample

Variable	Total (N = 2029)	Survivors (n = 1272)	Non-survivors (n = 757)	P-value
Age, years	78.0 (72.0 – 86.0)	77.0 (71.0 – 85.0)	79.0 (73.0 – 87.0)	< 0.001[a]
Male sex	1008 (49.7%)	605 (47.6%)	403 (53.2%)	0.013[b]
APACHE II score	25 (16 – 35)	18 (12 – 24)	37 (31 – 44)	< 0.001[a]
COVID-19 positive	240 (11.8%)	97 (7.6%)	143 (18.9%)	< 0.001[b]
CCI	–	–	–	0.031[b]
0	1292 (63.7%)	837 (65.8%)	455 (60.1%)	–
1	441 (21.7%)	279 (21.9%)	162 (21.4%)	–
≥ 2	296 (14.6%)	156 (12.3%)	140 (18.5%)	–
ICU Level	–	–	–	< 0.001[b]
2	227 (11.2%)	197 (15.5%)	30 (4.0%)	–
3	1802 (88.8%)	1075 (84.5%)	727 (96.0%)	–
Primary ICU admission diagnosis	–	–	–	< 0.001[b]
Sepsis	435 (21.4%)	184 (14.5%)	251 (33.2%)	–
Respiratory	654 (32.2%)	449 (35.3%)	205 (27.1%)	–
Neurological	157 (7.7%)	98 (7.7%)	59 (7.8%)	–
Cardiovascular	334 (16.5%)	218 (17.1%)	116 (15.3%)	–
Postoperative/Trauma	351 (17.3%)	267 (21.0%)	84 (11.1%)	–
Others	98 (4.8%)	56 (4.4%)	42 (5.5%)	–

Continuous variables are expressed as medians (quartiles 1–3). Categorical data are expressed as n (%).

[a] Mann–Whitney U test, [b] Chi-square test.

APACHE II = Acute Physiology and Chronic Health Evaluation II, COVID-19 = coronavirus disease 2019, CCI = Charlson Comorbidity Index, ICU = intensive care unit.

survivors ($p < 0.001$). Sepsis was substantially more common among non-survivors (33.2% vs. 14.5%), whereas postoperative/trauma admissions were more common among survivors (21.0% vs. 11.1%). ICU admissions categorized under respiratory system involvement were also more common among survivors (35.3% vs. 27.1%). Detailed distributions of diagnostic categories are presented in Table 1.

In the multivariable Cox proportional-hazards analysis (Table 2), older age (HR: 1.015 per year; 95% CI: 1.005–1.024; $p = 0.002$), male sex (HR: 1.160; 95% CI: 1.000–1.345; $p = 0.049$), admission to a level 3 ICU (HR: 1.579; 95% CI: 1.092–2.284; $p = 0.015$), and a higher APACHE II score (HR: 1.066 per point; 95% CI: 1.059–1.074; $p < 0.001$) were independently associated with an increased ICU mortality.

Compared with a primary diagnosis of postoperative/trauma related to ICU admission (reference category), sepsis (HR: 2.307; 95% CI: 1.583–3.363; $p < 0.001$), respiratory (HR: 1.645; 95% CI: 1.179–2.295; $p = 0.003$), and neurological diagnoses (HR: 2.044; 95% CI: 1.455–2.871; $p < 0.001$) were independently associated with a higher mortality risk. Admissions categorized as "others" were also independently associated with increased mortality, although the effect size was smaller (HR: 1.454; 95% CI: 1.011–2.090; $p = 0.044$)

APACHE II tertiles were defined according to the cohort's score distribution as T1 (≤18), T2 (19–31), and T3 (≥32), comprising 688, 690, and 651 patients, respectively. Kaplan–Meier survival analysis demonstrated a graded and stepwise decline in

Table 2. Cox Proportional-Hazards Model for ICU Mortality (N = 2029)

Variable	Hazard ratio	95% CI	P-value
Age (per year)	1.015	1.005–1.024	0.002
Male sex	1.160	1.000–1.345	0.049
ICU level (3rd vs. 2nd)	1.579	1.092–2.284	0.015
APACHE II (per point)	1.066	1.059–1.074	< 0.001
CCI (per point)	1.001	0.921–1.087	0.991
COVID-19 positive	1.050	0.866–1.274	0.618
Primary ICU admission diagnosis			
Postoperative/Trauma (reference)	1.000	–	–
Sepsis	2.307	1.583–3.363	< 0.001
Respiratory	1.645	1.179–2.295	0.003
Neurological	2.044	1.455–2.871	< 0.001
Cardiovascular	1.104	0.728–1.673	0.642
Others	1.454	1.011–2.090	0.044

CI = confidence interval, ICU = intensive care unit, APACHE II = Acute Physiology and Chronic Health Evaluation II, CCI = Charlson Comorbidity Index, COVID-19 = coronavirus disease 2019.

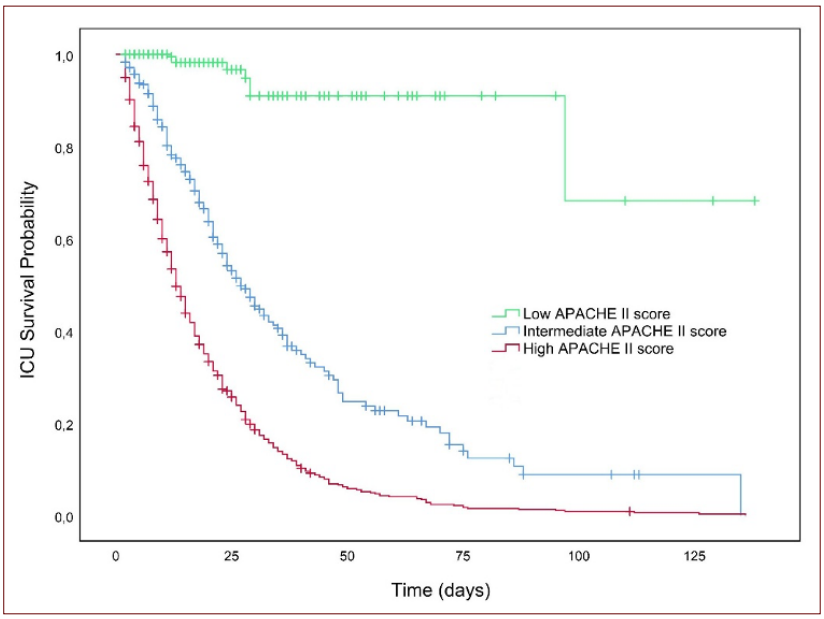


Figure 2. Kaplan–Meier survival curves according to APACHE II tertiles

APACHE II = Acute Physiology and Chronic Health Evaluation II, ICU, intensive care unit.

ICU survival across increasing tertiles (log-rank $p < 0.001$), with patients in the highest APACHE II tertile (T3) exhibiting the lowest survival throughout ICU follow-up (Figure 2).

Among ICU survivors, multivariable linear regression analysis of the log-transformed ICU LOS revealed that a higher CCI ($\beta = 0.144$; 95% CI: 0.084–0.204; $p < 0.001$) and COVID-19 positivity ($\beta = 0.600$;

Table 3. Multivariable Linear Regression Analysis for Predictors of ICU Length of Stay Among ICU Survivors (n = 1272)

Variable	β	95% CI	P-value
Age (per year)	0.000	-0.005 to 0.006	0.885
Male sex	-0.015	-0.113 to 0.083	0.766
APACHE II (per point)	0.000	-0.005 to 0.006	0.973
CCI (per point)	0.144	0.084 to 0.204	< 0.001
COVID-19 positive	0.600	0.417 to 0.784	< 0.001
ICU level (3rd vs 2nd)	0.021	-0.114 to 0.156	0.765
Diagnosis			
Postoperative/Trauma	Reference	–	–
Sepsis	0.794	0.631 to 0.958	< 0.001
Respiratory	0.209	0.075 to 0.344	0.002
Neurological	0.504	0.294 to 0.714	< 0.001
Cardiovascular	0.319	0.158 to 0.479	< 0.001
Others	1.009	0.759 to 1.259	< 0.001

ICU length of stay was log-transformed owing to a right-skewed distribution. All variables were simultaneously entered into the model. B-coefficients represent the change in the log-transformed ICU length of stay.

ICU = intensive care unit, APACHE II = Acute Physiology and Chronic Health Evaluation II, CCI = Charlson Comorbidity Index, COVID-19 = coronavirus disease 2019.

95% CI: 0.417–0.784; p < 0.001) were independently associated with a prolonged ICU stay (Table 3). In exponentiated terms, COVID-19 positivity corresponded to an approximately 82% longer ICU stay, while each one-point increase in the CCI was associated with an approximately 16% increase in the ICU LOS. The multivariable model accounted for 14.8% of the variance in the log-transformed ICU LOS (adjusted R2 = 0.148).

Compared with postoperative/trauma-related admissions (reference category), sepsis-related (β = 0.794; p < 0.001), respiratory (β = 0.209; p = 0.002), neurological (β = 0.504; p < 0.001), cardiovascular (β = 0.319; p < 0.001), and other (β = 1.009; p < 0.001) admissions were independently associated with a longer ICU stay.

DISCUSSION

This study identified distinct factors associated with mortality and recovery among older critically ill patients. The severity of acute illness at ICU admission, as quantified by the APACHE II score, was independently associated with short-term ICU mortality. By contrast, the burden of chronic comorbidity, measured using the CCI, was not independently associated with survival in the ICU after adjustment for acute severity. However, among survivors, a greater comorbidity burden was strongly associated with a prolonged ICU LOS. These findings highlight a clinically meaningful separation between factors associated with survival and those associated with recovery trajectories in geriatric critical care. Immediate survival was primarily linked to acute physiological severity, whereas the recovery duration was more closely related to the patient's underlying chronic health status.

Our findings regarding the APACHE II score align with its well-established role as a validated measure of acute illness severity (7, 8). We observed a graded decline in survival probability across



increasing APACHE II score tertiles, reinforcing its discriminatory capacity in the geriatric ICU context. Similar associations have been reported in diverse critically ill populations, including older patients with respiratory failure and postoperative neurosurgical cohorts (18, 19).

In contrast with the significant relationship observed in univariate analyses, the CCI was not independently associated with mortality in our multivariable Cox proportional-hazards model. Similar results have been reported in a systematic review, in which the researchers concluded that while comorbidities are more strongly associated with 3- to 12-month survival, short-term ICU mortality is more closely related to the diagnosis related to the admission and the severity score (20). Our findings extend this observation by directly contrasting mortality and recovery determinants within the same geriatric ICU cohort.

A notable finding in our study is that while age, male sex, and admission to a level 3 ICU independently predicted ICU mortality, none of these factors were associated with the ICU LOS among survivors after adjustment. The positive association between age and mortality may reflect age-related reductions in physiological reserve and adaptive capacity, which may limit patients' tolerance to acute stress during critical illness (21). The high mortality among patients admitted to the level 3 ICU likely reflects the concentration of more severely ill patients in higher-level care settings owing to triage practices. The absence of an association between age, sex, and ICU level with ICU LOS among survivors suggests that predictors of early mortality do not necessarily influence the pace of recovery once the acute phase is overcome.

Importantly, admission to a level 3 ICU was independently associated with mortality compared with level 2 ICU admission, even after adjustment for the APACHE II score and admission diagnosis; however, this likely reflects triage practices rather than a direct effect of ICU level. Patients requiring invasive mechanical ventilation or advanced organ support are preferentially admitted to level 3 units, indicating greater physiological instability that may not be fully captured by APACHE II scoring. By contrast, the absence of an association between ICU level and ICU LOS among survivors is consistent with prior evidence suggesting that structural ICU characteristics do not uniformly translate into a prolonged LOS (17).

We observed a significant association between the primary diagnosis associated with the ICU admission and mortality, with sepsis emerging as a particularly strong predictor of death in this cohort. Sepsis was markedly more prevalent among non-survivors, whereas postoperative/trauma- and respiratory system-related admissions were more common among survivors. These findings are consistent with prior reports in geriatric critical care that sepsis is associated with disproportionately high mortality rates (22). Furthermore, sepsis should not be viewed in isolation; in our cohort, the sepsis and respiratory groups likely represent a broad spectrum of life-threatening organ dysfunctions, including acute respiratory distress syndrome, which are major drivers of intensive care support and adverse outcomes. Several mechanisms may contribute to this association. In contrast with many postoperative patients, whose physiological stressors are planned and perioperatively optimized, patients with sepsis often present with unanticipated systemic inflammatory injury that can rapidly progress to organ dysfunction (23). Beyond its impact on mortality, the admission diagnosis was also independently associated with the ICU LOS, further indicating that the nature and intensity of the underlying clinical condition may also be associated with differences in recovery duration.

The ICU LOS in the present study was analyzed exclusively among survivors because ICU death is an outcome that prematurely ends the ICU stay, potentially masking the factors associated with a prolonged recovery. Accordingly, an important

finding of our study was the identification of the CCI as an independent predictor of the ICU LOS in this subgroup. For each point extra in the CCI, the ICU LOS was approximately 16% longer. Previous studies also revealed an association between the comorbidity burden and ICU LOS (24). A plausible biological explanation for this association involves the concept of homeostenosis, which refers to the age-related narrowing of physiological reserve (4). Older patients with a high comorbidity burden may have a reduced capacity for tissue repair and immune recovery, as well as a greater dependence on prolonged organ support, which may in turn contribute to longer ICU stays (21).

After adjustment for baseline variables, COVID-19 positivity was not independently associated with mortality in our cohort. This aligns with contemporary evidence suggesting that the implementation of standardized care protocols, including corticosteroid therapy and improved respiratory management, may have attenuated the high mortality rates observed in the earliest stages of the pandemic (12). Our results indicate that while survival among older patients with COVID-19 may have improved, such an improvement may be accompanied by a longer ICU stay and, therefore, a greater ICU resource use.

As the geriatric population continues to grow, healthcare systems must move beyond binary predictions of survival toward a more nuanced understanding of recovery patterns (20, 21). Our results suggest that clinicians may consider using the APACHE II score for immediate mortality risk stratification, while comorbidity scores such as the CCI may help anticipate the expected duration of ICU stay. This distinction between survival and recovery potential is important for shared decision-making with families. Accordingly, identifying survivors who are likely to experience a prolonged ICU course owing to a high comorbidity burden may enable earlier, goal-concordant care planning.

The strengths of the present investigation include its sample size (N = 2,029) and the six-year study period encompassing both the COVID-19 pandemic and the post-pandemic period. A notable methodological strength was the evaluation of the LOS exclusively among survivors to better characterize determinants of recovery independent of early mortality, thereby reducing the potential bias introduced by artificially shortened ICU stays.

However, several limitations must be acknowledged. First, the retrospective, single-center design may limit the generalizability of our findings to healthcare systems with different ICU admission criteria, discharge practices, or resource availability. Second, the reliance on ICD-10 coding for diagnostic categorization is a limitation, as administrative codes may carry a risk of misclassification and may not always reflect the full complexity of overlapping clinical conditions. Although we used primary admission diagnoses for classification to ensure a standardized classification approach, we acknowledge that critically ill older adults often present with complex clinical heterogeneity that may not be fully captured by single diagnostic categories. To mitigate this, we incorporated validated clinical scoring systems, specifically the CCI to account for chronic health status and the APACHE II score for acute physiological severity, providing a more multidimensional and robust assessment of patient complexity. Additionally, overlap syndromes such as sepsis-associated acute respiratory distress syndrome may not have been fully represented within mutually exclusive diagnostic groups. In addition, we did not include formal measures of frailty or the pre-admission functional status, which are increasingly recognized as important determinants of outcomes in geriatric critical care and may partly mediate the relationship between the comorbidity burden and recovery trajectories. Third, treatment-related variables reflecting the post-admission course, such as the duration of mechanical ventilation or cumulative vasopressor exposure, were not included in the regression models because they only occur after ICU admission



and are closely intertwined with the study outcomes. The inclusion of such time-dependent variables may introduce temporal ambiguity, the appearance of reverse causation, and mediation bias. Due to the retrospective design and the routine sequential use of invasive mechanical ventilation and non-invasive mechanical ventilation in our clinical practice, the exact duration of each respiratory support modality could not be separately quantified. Furthermore, although we analyzed the ICU LOS exclusively among survivors to reduce bias related to early mortality, alternative statistical approaches such as competing-risk modeling were not applied. Finally, the study was limited to ICU-level outcomes, and we did not assess long-term functional recovery, cognitive outcomes, or quality of life after hospital discharge, which are increasingly recognized as essential endpoints in the care of critically ill older adults (25). Consistent data for in-hospital or 28-day mortality were not available; while ICU mortality is a robust indicator of acute survival, the lack of post-discharge follow-up is a limitation. Future prospective multicenter studies in which long-term functional outcomes are incorporated are warranted to further clarify the relationship between survival and recovery trajectories in older patients admitted to the ICU.

In conclusion, among critically ill older adults, survival in the ICU was primarily associated with the severity of acute physiological derangement at admission, whereas the duration of recovery among survivors was more strongly associated with the pre-existing comorbidity burden. These findings underscore the importance of conceptually separating predictors of mortality from factors associated with a prolonged ICU stay.

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