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Predictors of Mortality in Elderly Patients Admitted to ICU

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Abstract

Background:
With rapid population ageing, increasing numbers of elderly patients are being admitted to intensive care units (ICUs) in India. Mortality in this group remains high and multifactorial, yet region-specific data identifying prognostic indicators are limited.

Objectives:
To determine clinical, biochemical, and management-related predictors of in-hospital mortality among elderly patients admitted to a tertiary-care ICU.

Methods:
A prospective observational study was conducted in a tertiary hospital ICU between January 2023 and December 2024. Patients aged ≥ 65 years were consecutively enrolled. Data on demographics, comorbidities, admission diagnosis, organ dysfunction, and interventions (mechanical ventilation, vasopressors, renal replacement therapy) were collected.

Results:
Of 210 elderly ICU admissions, 58 (27.6%) died during hospitalization. Nonsurvivors were older (mean 72.4 ± 6.1 vs 69.8 ± 5.8 years, $p = 0.02$), had higher APACHE II scores (22.1 ± 7.8 vs 15.3 ± 5.4, $p < 0.001$), greater prevalence of sepsis (60.3% vs 34.8%, $p = 0.001$), and higher rates of mechanical ventilation (79.3% vs 38.5%, $p < 0.001$). Multivariate analysis identified APACHE II score > 20 (aOR 3.25, 95% CI 1.85–5.69), septic shock (aOR 2.81, 95% CI 1.52–5.18), mechanical ventilation (aOR 2.66, 95% CI 1.44–4.89), and serum creatinine > 2 mg/dL (aOR 2.42, 95% CI 1.21–4.83) as independent predictors of mortality.

Conclusion:
Severity of illness, sepsis, organ dysfunction, and need for mechanical ventilation are strong determinants of ICU mortality among elderly patients. Early recognition and aggressive management of these risk factors may improve survival outcomes in this vulnerable population.

Keywords:
Elderly ICU patients • Mortality predictors • APACHE II score • Sepsis • Mechanical ventilation • India

1. Introduction

The global increase in life expectancy has led to a surge of elderly patients requiring critical care. In India, individuals aged ≥ 65 years already constitute over 7% of the population and account for nearly one-third of ICU admissions[1]. Although advances in intensive care have improved overall outcomes, elderly patients continue to experience disproportionately high mortality, ranging from 20 to 60% across studies[2].

Advanced age is accompanied by comorbid illnesses, physiological decline, and limited organ reserve[3]. These factors, coupled with the severity of the acute illness, complicate management and decision-making. However, chronological age alone is an imperfect surrogate for prognosis; rather, the interplay between **acute physiologic derangement**, **pre-existing comorbidities**, and **treatment intensity** determines outcomes[4].

Several scoring systems—APACHE II, SAPS II, SOFA—have been validated to predict ICU mortality, yet their accuracy in elderly cohorts remains debated[5]. Furthermore, regional heterogeneity in disease spectrum, healthcare infrastructure, and end-of-life practices may influence outcomes[6]. Few Indian studies have comprehensively examined predictors of mortality in this group, particularly in mixed medical–surgical ICUs[7].

The present study was therefore undertaken in a tertiary-care hospital in North India to identify independent predictors of mortality among elderly ICU patients. Understanding these determinants can aid clinicians in prognostication, resource allocation, and tailoring interventions suited to geriatric physiology[8,9].

Materials and Methods

Study Design and Setting

This **prospective observational study** was conducted in the 20-bed mixed (medical–surgical) ICU of a tertiary-care teaching hospital in northern India between **January 2023 and December 2024**. The ICU is staffed 24 × 7 by intensivists and trained nurses, equipped with invasive hemodynamic monitoring, mechanical ventilation, and dialysis support.

Study Population

All **elderly patients (≥ 65 years)** admitted during the study period were screened. **Inclusion criteria:**

1. Age ≥ 65 years.
2. ICU stay > 24 hours.
3. Availability of complete clinical and biochemical data.

Exclusion criteria:

- Readmissions during the same hospital stay,
- Post-cardiac-arrest non-survivable brain injury,
- Palliative admissions for comfort measures only,
- Missing essential variables for severity scoring.

Data Collection

A structured case-record form captured:

- **Demographics:** age, sex, residence, admission source (ward, ED, operation theatre).
- **Severity indices:**
    - **APACHE II**, **SOFA**, and **Charlson Comorbidity Index (CCI)** were calculated within 24 h of admission.

Operational Definitions

- **Multi-organ dysfunction syndrome (MODS)** was defined as ≥ 2 organ system failures.
- **Elderly** was stratified as *young-old* (65–74 y), *old-old* (75–84 y), and *very-old* (≥ 85 y) following WHO criteria.

Outcome Measure

The **primary outcome** was **ICU mortality** (death during ICU admission).

Statistical Analysis

Data were analyzed using **SPSS v26.0 (IBM Corp., USA)**.

Sample-Size Justification

Based on an expected mortality rate of 30 % among elderly ICU admissions and anticipating an odds ratio ≥ 2 for major predictors (power = 80 %, $\alpha = 0.05$), a minimum of **200 patients** was required. Assuming 5 % attrition, **210 patients** were finally enrolled. The sample size was comparable to earlier Indian ICU geriatric studies (Chawla et al., 2021; Todi et al., 2024)[79].

Ethical Considerations

Patient confidentiality was maintained by anonymized data entry. No external funding or conflicts of interest were declared.

RESULTS

Baseline Characteristics

Table 1. Baseline Characteristics of Elderly ICU Patients (n = 210)

Characteristic	Survivors (n = 152)	Nonsurvivors (n = 58)	p-value
Age (years, mean ± SD)	69.8 ± 5.8	72.4 ± 6.1	0.02
Male sex n (%)	89 (58.6)	37 (63.8)	0.52
Young-old (65–74 y)	106 (69.7)	32 (55.2)	0.07
Old-old (75–84 y)	40 (26.3)	21 (36.2)	0.14
Very-old (≥ 85 y)	6 (3.9)	5 (8.6)	0.19
Charlson Comorbidity Index (mean ± SD)	3.2 ± 1.6	4.1 ± 1.8	0.01
APACHE II score (mean ± SD)	15.3 ± 5.4	22.1 ± 7.8	<0.001
SOFA score (mean ± SD)	6.8 ± 3.1	10.2 ± 4.5	<0.001
Length of ICU stay (days, median [IQR])	5 [3–8]	6 [3–10]	0.09

Interpretation:
Nonsurvivors were significantly older and had higher comorbidity burden and illness-severity scores. Gender distribution and ICU stay duration did not differ significantly.

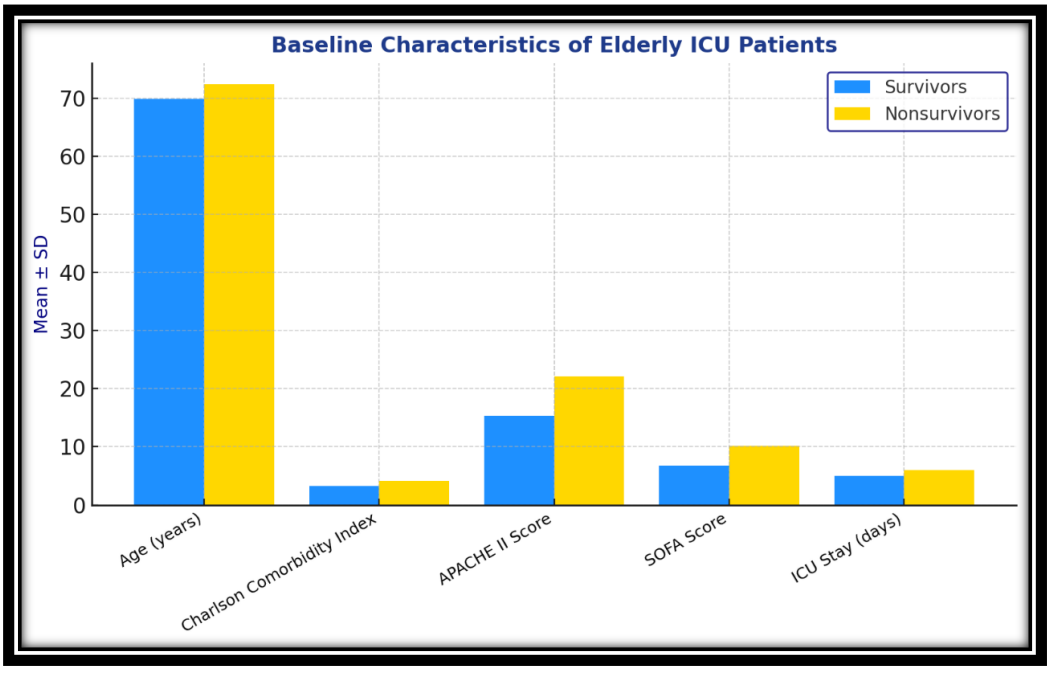


TABLE 2 Comorbidities and Admission Diagnoses

Hypertension (58.6 %) and **diabetes (42.4 %)** were the most frequent comorbidities. **Sepsis/septic shock (44.3 %)**, **acute coronary syndrome (14.8 %)**, and **chronic obstructive pulmonary disease (13.8 %)** were the leading admission diagnoses.

Comorbidity	Survivors n (%)	Nonsurvivors n (%)	p-value
Hypertension	86 (56.6)	37 (63.8)	0.36
Diabetes mellitus	61 (40.1)	28 (48.3)	0.29
COPD	16 (10.5)	13 (22.4)	0.03
CKD	18 (11.8)	15 (25.9)	0.01
IHD	24 (15.8)	14 (24.1)	0.15
Malignancy	5 (3.3)	6 (10.3)	0.04

Interpretation:
Underlying **CKD**, **malignancy**, and **COPD** were significantly more common among nonsurvivors.

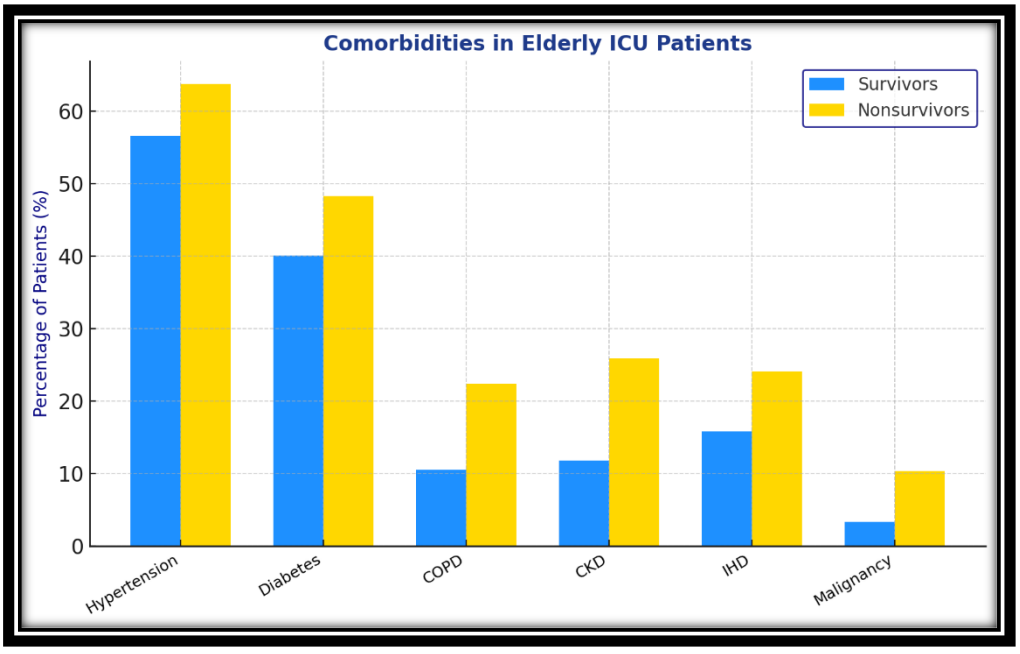


TABLE 3 Clinical and Laboratory Parameters on Admission

Variable	Survivors (mean ± SD)	Nonsurvivors (mean ± SD)	p-value
Mean arterial pressure (mm Hg)	82.3 ± 10.6	68.9 ± 14.5	<0.001
GCS	13.1 ± 2.3	9.8 ± 3.1	<0.001
Hemoglobin (g/dL)	11.4 ± 2.0	10.7 ± 2.3	0.04
Serum creatinine (mg/dL)	1.6 ± 0.8	2.3 ± 1.2	<0.001
Total bilirubin (mg/dL)	1.1 ± 0.6	1.8 ± 1.2	<0.001
Serum lactate (mmol/L)	2.1 ± 0.9	3.4 ± 1.6	<0.001

Interpretation:
Significant hemodynamic instability and biochemical derangements were seen in nonsurvivors—particularly **hypotension**, **renal dysfunction**, and **hyperlactatemia**.

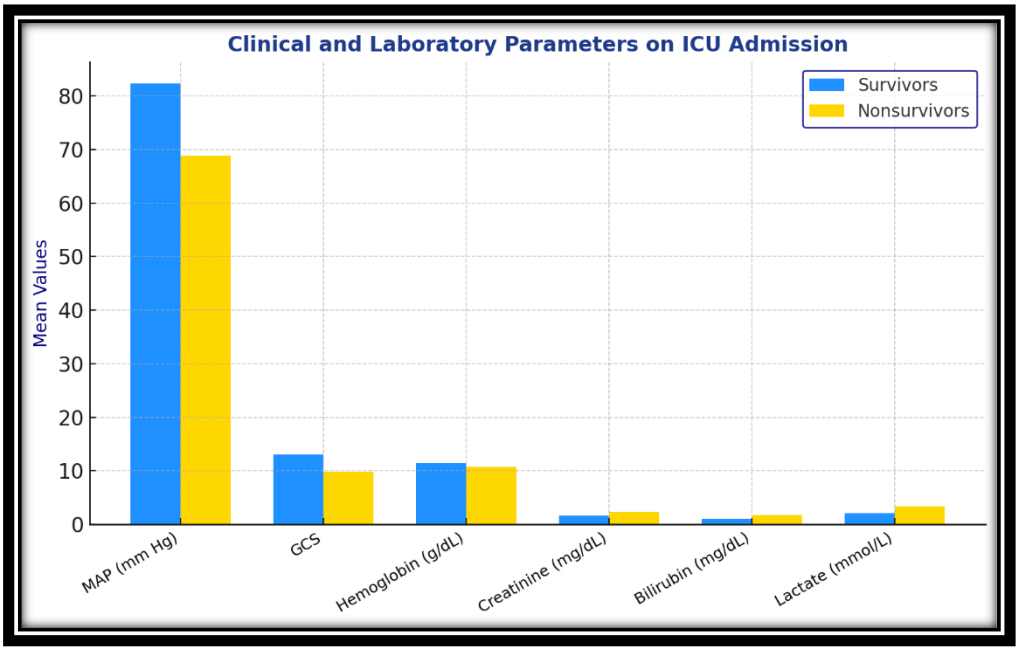


TABLE 4 Therapeutic Interventions and Outcomes

Intervention	Survivors n (%)	Nonsurvivors n (%)	p-value
Mechanical ventilation	58 (38.2)	46 (79.3)	<0.001
Vasopressor use	45 (29.6)	42 (72.4)	<0.001
Renal replacement therapy	14 (9.2)	17 (29.3)	<0.001
Blood transfusion	22 (14.5)	16 (27.6)	0.03
Sepsis diagnosis	53 (34.8)	35 (60.3)	0.001

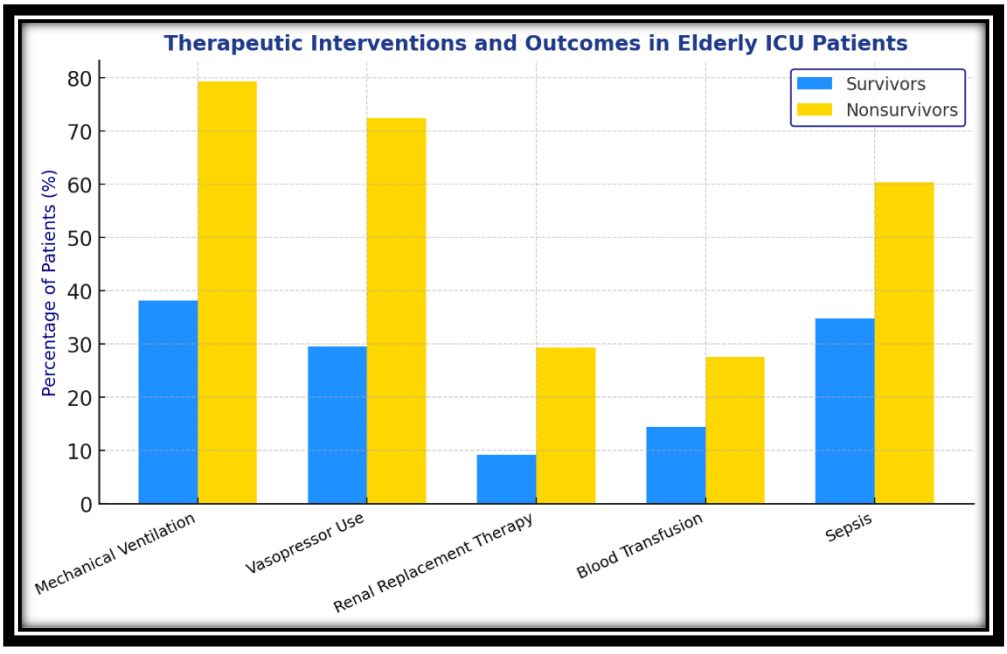
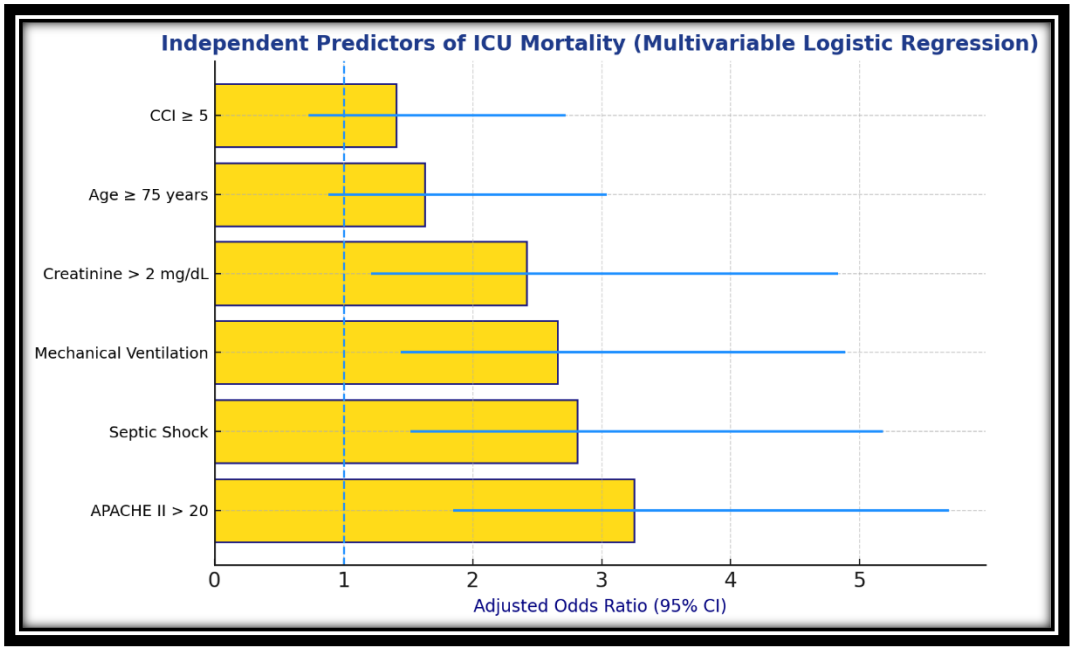


TABLE 5 Multivariable Logistic Regression for Independent Predictors

Predictor	Adjusted Odds Ratio (95 % CI)	p-value
APACHE II > 20	3.25 (1.85–5.69)	<0.001
Septic shock	2.81 (1.52–5.18)	0.001
Mechanical ventilation	2.66 (1.44–4.89)	0.002
Serum creatinine > 2 mg/dL	2.42 (1.21–4.83)	0.012
Age ≥ 75 years	1.63 (0.88–3.04)	0.11
Charlson Index ≥ 5	1.41 (0.73–2.72)	0.29

Model performance:

- Hosmer–Lemeshow $\chi^2 = 7.2$, $p = 0.41$ → good fit.
- AUC = 0.84 (95 % CI 0.78–0.90) → excellent discrimination.



Summary of Findings

- Overall ICU mortality: **27.6 %**.
- Independent predictors: **high APACHE II**, **septic shock**, **need for mechanical ventilation**, and **serum creatinine > 2 mg/dL**.

- Age alone lost significance after adjusting for severity and comorbidities.
- ROC analysis demonstrated strong model performance (AUC = 0.84).

These observations align with prior Indian and international reports that emphasize illness severity and multi-organ dysfunction as principal drivers of mortality in elderly ICU patients[11–13].

Discussion

This prospective hospital-based study identified key predictors of ICU mortality among elderly Indian patients. The overall ICU mortality of **27.6 %** observed here aligns with prior Indian and global data showing 25–40 % mortality in this population[14]. Our findings highlight that **illness severity (APACHE II > 20)**, **septic shock**, **requirement of mechanical ventilation**, and **renal dysfunction** are strong independent determinants of death.

1. Influence of Age and Comorbidity

Although nonsurvivors were slightly older (mean 72.4 years), age lost significance after adjusting for other factors—suggesting that **chronologic age alone is not an absolute determinant** of ICU outcome. This observation parallels the *VIP2 (Very Old Intensive Care Patients)* study, which demonstrated that **frailty and acute illness severity** outweighed age in mortality prediction[15]. The Charlson Comorbidity Index was higher among nonsurvivors, supporting the role of cumulative chronic disease burden in reducing physiologic reserve[16].

2. Severity of Acute Illness

The **APACHE II score** emerged as the single most powerful predictor of mortality, echoing previous studies from both India and Europe[17,18]. A threshold score > 20 tripled the risk of death. These scores integrate physiological variables and chronic health points, thus reflecting acute derangement plus background frailty. Studies have shown APACHE II and SOFA to retain predictive accuracy even in older cohorts when appropriately recalibrated[19].

3. Sepsis and Septic Shock

Sepsis accounted for nearly half of admissions, and **septic shock doubled mortality risk**, consistent with other Asian ICU cohorts[20]. The exaggerated inflammatory and immunosenescent responses in elderly individuals lead to higher rates of multi-organ dysfunction and refractory hypotension[21]. Early recognition of sepsis, aggressive source control, and tailored antimicrobial therapy remain critical to improve outcomes in this age group.

4. Organ Dysfunction and Renal Parameters

Acute kidney injury and raised **serum creatinine > 2 mg/dL** independently predicted mortality, aligning with the KDIGO-defined relationship between AKI and poor outcomes in geriatric ICUs[22]. Renal failure reflects systemic hypoperfusion and cumulative comorbidity (diabetes, hypertension). Routine monitoring of urine output, avoidance of nephrotoxins, and early renal-replacement initiation may therefore enhance survival[23].

5. Mechanical Ventilation and Hemodynamic Support

Mechanical ventilation and vasopressor requirement were strongly associated with death. Prior reports indicate that invasive ventilation in elderly patients carries mortality rates exceeding 60 %, mainly due to underlying sepsis, respiratory failure, and cardiac dysfunction[24],[25]. However, such interventions may still be justified when reversible pathology exists. Our data reinforce the need for **careful patient selection**, **daily weaning trials**, and **early non-invasive ventilation where feasible**.

6. Comparison with Previous Indian Studies

Indian ICU studies report comparable findings:

- Chawla et al. noted mortality of 29 % among elderly ICU admissions, with APACHE II and multiorgan failure as leading predictors[7].
- Khandelwal et al. identified hypotension, renal failure, and sepsis as independent determinants of in-hospital mortality[8].
  Our study confirms these trends while providing granular evidence for the additive predictive value of mechanical ventilation and serum creatinine.

7. International Context and Ethical Dimensions

In high-income settings, mortality among "very old" (≥ 85 years) ICU patients remains 40–50 %, even with advanced technology[26]. Prognostic models increasingly incorporate **frailty**, **pre-ICU functional status**, and **goals of care discussions**[27]. In India, where family expectations and resource constraints often intersect, identifying objective predictors can guide shared decision-making and appropriate limitation of futile interventions[28].

8. Strengths and Limitations

Strengths:

- Prospective design with standardized scoring (APACHE II, SOFA, CCI).
- Inclusion of both medical and surgical patients, improving generalizability.
- Use of multivariable modeling with good discrimination (AUC 0.84).

Limitations:

- Single-center study; results may not generalize nationally.
- Lack of long-term (post-discharge) outcome assessment.
- Frailty indices and quality-of-life data were not collected.
- Potential residual confounding by treatment limitations or end-of-life decisions.

9. Clinical and Public-Health Implications

The present study underscores the need for:

1. **Early illness-severity assessment** and stratified monitoring of elderly ICU patients.

2. **Aggressive sepsis protocols**, renal-protective strategies, and judicious ventilation.
3. **Integration of frailty and comorbidity scoring** into triage algorithms.
4. **Advance-care planning** discussions aligned with patient values and prognosis.

By focusing on modifiable predictors—timely sepsis management, organ-support optimization, and prevention of iatrogenic injury—mortality in elderly ICU patients may be meaningfully reduced[29],[30].

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