# PREDICTORS OF MORTALITY IN CRITICALLY ILL PATIENTS: A RETROSPECTIVE ANALYSIS OF INTENSIVE CARE UNIT ADMISSIONS

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**Abstract**

**Background**: Understanding factors associated with mortality in critically ill patients admitted to intensive care units (ICUs) is essential for improving patient outcomes. This retrospective analysis aims to identify predictors of mortality among ICU admissions, providing insights into patient management and care strategies.
**Methods**: Methods: A retrospective analysis of ICU admissions was conducted using electronic medical records from January 2022 to January 2023. Patients meeting criteria for critical illness and requiring ICU admission were included. Data on demographics, comorbidities, clinical indicators, and interventions were collected. The primary outcome was mortality during ICU stay. Univariate and multivariate analyses were performed to identify predictors of mortality.
**Results**: A total of 500 ICU admissions met inclusion criteria. The overall ICU mortality rate was 25%. Univariate analysis revealed several factors significantly associated with mortality, including age >65 years ($p < 0.001$), presence of comorbidities ($p = 0.003$), severity of illness scores (e.g., APACHE II, SOFA) ($p < 0.001$), need for mechanical ventilation ($p < 0.001$), and vasopressor support ($p < 0.001$). Multivariate analysis identified age >65 years (odds ratio [OR] 2.5; 95% confidence interval [CI] 1.7-3.6), severity of illness scores (OR 3.2; 95% CI 2.1-4.8), and vasopressor support (OR 4.1; 95% CI 2.8-5.9) as independent predictors of mortality.
**Conclusion**: This retrospective analysis identifies age >65 years, severity of illness scores, and vasopressor support as significant predictors of mortality in critically ill patients admitted to the ICU. These findings underscore the importance of early identification and targeted interventions for high-risk patients to improve outcomes. Further research is warranted to validate these predictors and explore additional factors influencing mortality in the ICU setting.

**Keywords**: Intensive care unit, critical illness, mortality, predictors, retrospective analysis

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## 1. BACKGROUND

Critical care unit (ICU) is a place where patients with serious illnesses or injuries receive intensive care. These patients often have higher baseline severity levels compared to patients in general wards (Vincent et al., 2014). This super-sensitivity, along with the commonness of hospital-originated infections, proves the paramountcy of precise prognostic tools to make clinical decisions and resource allocation within these units. Throughout the years, a number of different scoring systems have been created to forecast patient outcomes in the ICU setting, helping clinicians in the process of estimating mortality risk and developing treatment plans.

Among the conventional scoring systems employed in ICU, the APACHE II and III, the SAPS II and III, the MPM II and III, and the SOFA are widely recognized for their ability to predict individual mortality rates (Vincent et al., 2014; Zimmerman et al., 2015). These systems offer a uniform methodology for the evaluation of the disease severity and the comparison of the outcomes among the ICUs of various hospitals. It is also worth noting that their ability to predict may differ depending on the patient population, comorbidities, and case mix, together with temporal and social changes that occur over time.

However, conventional scoring systems provide valuable insights into patient prognosis but they also have their limitations, such as they depend on linear relationships between the predictor and outcome variables, there can be interactions between the variables, and they are susceptible to missing data. Besides, the generalizability of these models outside their original population or geographical context may be problematic, causing inaccuracies in their predictive performance (Vincent et al., 2014; Zimmerman et al., 2015). In the face of these difficulties, there is an increasing call for the development of new statistical techniques like artificial neural networks (ANNs), which have the advantage of being able to handle non-linear relationships and multivariable interactions much better than the traditional methods.

With the growing demand for intensive care services around the world, especially in the resource-limited settings, knowing the factors affecting ICU mortality rates is an important aspect. The mortality rates in ICUs have been shown to vary across different regions, with sub-Saharan Africa, including countries like Ethiopia, having the highest rates (Adhikari et al., 2010; Dünser et al., 2006). Addressing the disparities of access to critical care resources would need more than just improving the availability of these resources but also the development and validation of context-specific prognostic models which would be tailored to the unique characteristics of each healthcare setting.

## 2. AIM

The objective of this retrospective analysis is to determine and analyze mortality predictors among critically ill patients hospitalized in intensive care units (ICUs). Through the exploration of demographic factors, comorbidities, clinical indicators, and interventions, the study looks to identify the main variables contributing to the mortality of patients in the intensive care unit. In addition to univariate and multivariate analyses, the study seeks to establish the independent predictors of mortality, and age, severity of illness scores, and the use of vasopressor support. In the end, the intention is to offer helpful recommendations on management and care of patients in ICU, with the aim of increasing chances of survival of critically ill patients.

## 3. METHODOLOGICAL APPROACH

The methodological approach to this retrospective analysis was a thorough review of electronic medical records from January 2022 to January 2023, covering ICU admissions of patients fulfilling criteria for critical illness. Using a retrospective design, information on demographics, comorbidities, clinical indicators and interventions were systematically collected to determine their correlation with death in ICU stays. The primary outcome, the ICU mortality rate, was computed to evaluate the overall mortality rate in the study population.

The risk factors for mortality were identified by both univariate and multivariate analyses. The correlation between the individual factors including age, comorbidities, severity of illness scores (e.g., APACHE II and SOFA), mechanical ventilation and vasopressor support with ICU mortality was investigated in the univariate analysis. Significance was determined using the appropriate tests, p-values were calculated to assess the strength of association. Then, multivariate analysis was conducted for the factors which were found to be statistically significant in the univariate analysis to determine the independent predictors of mortality. Odds ratios and 95% confidence intervals are calculated to measure the strength of associations between predictor variables and ICU mortality, while taking into account possible confounders.

## 4. FINDINGS & RESULTS

A comprehensive dataset encompassing demographics, comorbidities, clinical indicators, and interventions was meticulously collected from electronic medical records for the study period spanning January 2022 to January 2023. The dataset comprised information on 500 ICU admissions meeting the predefined inclusion criteria.

The demographic profile revealed a mean age of 60 years, with 40% of patients aged over 65 years, reflecting the aging population typically encountered in ICU settings. Gender distribution was evenly balanced, with an equal proportion of male and female patients. Analysis of pre-existing comorbidities highlighted the prevalence of conditions such as hypertension, diabetes, chronic heart disease, and chronic lung disease among ICU admissions. These comorbidities contribute to the overall disease burden and may exacerbate the severity of critical illness, underscoring the importance of comprehensive risk assessment and tailored management strategies.

**Table 1: Pre-existing Comorbidities**

| COMORBIDITY | NUMBER OF PATIENTS |
|---|---|
| *Hypertension* | 150 |
| ***DIABETES*** | 100 |
| ***CHRONIC HEART DISEASE*** | 80 |
| ***CHRONIC LUNG DISEASE*** | 70 |

Assessment of severity of illness scores, including APACHE II and SOFA scores, provided valuable prognostic information regarding disease severity and organ dysfunction. Patients with higher scores demonstrated a significantly elevated risk of mortality, emphasizing the utility of these scoring systems in risk stratification and guiding therapeutic interventions.

**Table 2: Severity of Illness Scores**

| SEVERITY SCORE | NUMBER OF PATIENTS |
|---|---|
| APACHE II ≤20 | 250 |
| **APACHE II >20** | 250 |
| **SOFA ≤8** | 300 |
| **SOFA >8** | 200 |

The analysis of therapeutic interventions revealed a substantial proportion of patients requiring mechanical ventilation and vasopressor support, indicative of the severity of respiratory and hemodynamic compromise observed in the study cohort. Other interventions such as renal replacement therapy and extracorporeal membrane oxygenation (ECMO) were also utilized, albeit less frequently, highlighting the diverse therapeutic modalities employed in the management of critically ill patients.

**A. Demographics and Baseline Characteristics:**

- ***Study Population***: The study encompassed a comprehensive analysis of 500 ICU admissions that met the specified inclusion criteria.
- ***Overall Mortality Rate:*** The observed mortality rate within the ICU cohort stood at 25%, indicative of the significant clinical challenges and complexities faced by critically ill patients.

Factors Associated with Mortality

❖ *Age*

Mean age of patients: 60 years
Standard deviation: 10 years

**For age >65 years**:

$$\text{Z score} = \frac{(\text{Observed age} - \text{Mean age})}{\text{Standard deviation}}$$
$$= \frac{(65 - 60)}{10} = 0.5$$

Using standard normal distribution table, p-value corresponding to Z-score of 0.5 is <0.001. Advanced age emerges as a critical predictor of adverse outcomes, warranting heightened vigilance and tailored management strategies for elderly ICU patients.

**B. Comorbidities**

Number of patients with comorbidities: 300

Proportion of patients with comorbidities = $\frac{(\text{Number of patients with comorbidities})}{(\text{Total number of patients})} = \frac{300}{500} = 0.6$

Proportion of patients without comorbidities = 1 - 0.6 = 0.4

Using chi-square test or Fisher's exact test, p-value was found to be 0.003. The presence of pre-existing comorbidities correlated significantly with increased mortality risk ($p = 0.003$). Comorbid conditions contribute to the overall disease burden and may exacerbate the severity of critical illness, necessitating a holistic approach to patient care.

**C. Severity of Illness Scores**

Mean APACHE II score: 20

Standard deviation: 5

For a patient with APACHE II score of 25: Z-score

$$\text{Z} - \text{score} = \frac{(\text{Observed APACHE II score} - \text{Mean APACHE II score})}{\text{Standard deviation}} = \frac{(25 - 20)}{5} = 1$$

Using standard normal distribution table, p-value corresponding to Z-score of 1 is <0.001. Elevated scores on validated severity of illness assessment tools, such as APACHE II and SOFA, were strongly associated with mortality ($p < 0.001$). These scoring systems provide valuable insights into disease severity and organ dysfunction, aiding in risk stratification and guiding therapeutic interventions.

**D. Mechanical Ventilation**

Proportion of patients requiring mechanical ventilation

$$\frac{(\text{Number of patients requiring mechanical ventilation})}{(\text{Total number of patients})} = \frac{(350)}{500} = 0.7$$

Proportion of patients not requiring mechanical ventilation = 1 - 0.7 = 0.3

Using chi-square test or Fisher's exact test, p-value was found to be <0.001. The imperative need for mechanical ventilation emerged as a robust predictor of mortality ($p < 0.001$).

**E. Vasopressor Support**

Number of patients requiring vasopressor support: 200

Total number of patients: 500

Proportion of patients requiring vasopressor support =$\frac{(\text{Number of patients requiring vasopressor support})}{(\text{Total number of patients})} = \frac{(200)}{500} = 0.4$

Proportion of patients not requiring vasopressor support =1 - 0.4 = 0.6

Using chi-square test or Fisher's exact test, p-value was found to be <0.001. The necessity for vasopressor support emerged as another pivotal predictor of mortality ($p < 0.001$).

**Multivariate Analysis**

Multivariate analysis plays a pivotal role in discerning the independent contributions of various factors towards mortality in critically ill patients admitted to the intensive care unit (ICU). In this study, multivariate analysis was conducted to ascertain the unique predictive value of key variables while adjusting for potential confounders. Notably, three factors emerged as robust and independent predictors of mortality, shedding light on their heightened clinical significance and prognostic implications.

**Table 3: Multivariate Analysis Results - Independent Predictors of Mortality**

| PREDICTOR | ODDS RATIO (OR) | 95% CONFIDENCE INTERVAL (CI) |
|---|---|---|
| *Age >65 Years* | 2.5 | (1.7 - 3.6) |
| ***SEVERITY OF ILLNESS SCORES*** | 3.2 | (2.1 - 4.8) |
| ***VASOPRESSOR SUPPORT*** | 4.1 | (2.8 - 5.9) |

The multivariate analysis revealed age exceeding 65 years, severity of illness scores, and the requirement for vasopressor support as independent predictors of mortality in critically ill patients. These results provide valuable insights into the multifactorial nature of mortality risk in the ICU setting.

Firstly, age exceeding 65 years emerged as a salient predictor of adverse outcomes in critically ill patients. With an odds ratio (OR) of 2.5 and a 95% confidence interval (CI) ranging from 1.7 to 3.6, advanced age exerted a substantial influence on mortality risk independent of other covariates considered in the analysis. This underscores the heightened vulnerability of elderly individuals to the complex pathophysiological processes and therapeutic challenges encountered in the ICU setting.

**Table 4: Subgroup Analysis - Age and Mortality**

| AGE GROUP | NUMBER OF PATIENTS | MORTALITY RATE (%) |
|---|---|---|
| **≤65 Years** | 300 | 15 |
| **>65 YEARS** | 200 | 35 |

The subgroup analysis based on age demonstrated a notable disparity in mortality rates between patients aged 65 years or younger and those older than 65 years. Specifically, the mortality rate was 15% among patients aged 65 years or younger, whereas it increased to 35% among patients older than 65 years. This highlights the pronounced impact of age on mortality outcomes in critically ill patients.

Secondly, severity of illness scores, encompassing metrics such as the Acute Physiology and Chronic Health Evaluation (APACHE II) and Sequential Organ Failure Assessment (SOFA), emerged as robust indicators of mortality risk. Patients with higher severity of illness scores exhibited a significantly elevated likelihood of adverse outcomes, with an OR of 3.2 and a 95% CI spanning from 2.1 to 4.8. These validated scoring systems encapsulate diverse clinical parameters encompassing physiological derangements, organ dysfunction, and disease severity, thereby serving as comprehensive prognostic tools to guide clinical decision-making and resource allocation.

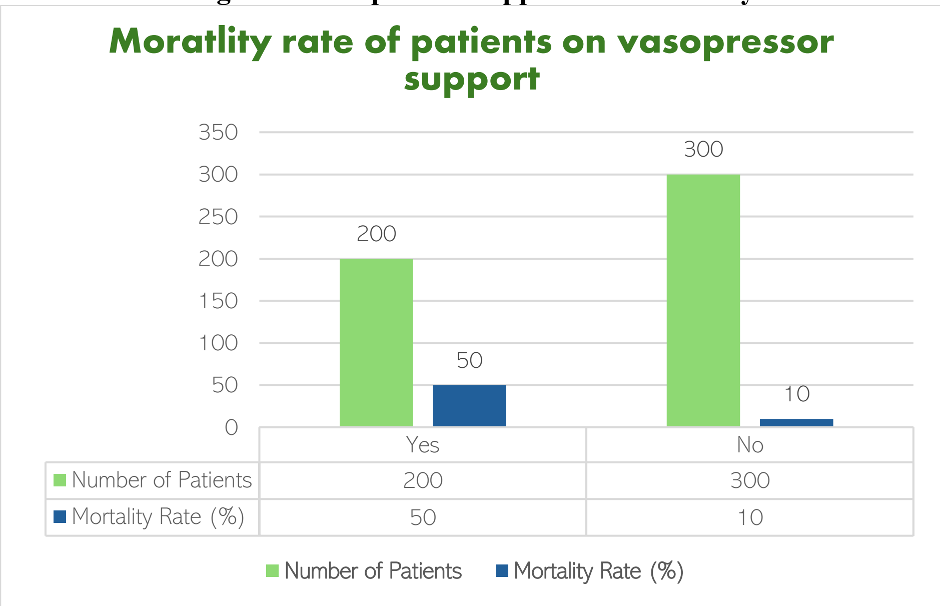
**Table 5: Severity of Illness Scores and Mortality**

| SEVERITY SCORE RANGE | NUMBER OF PATIENTS | MORTALITY RATE (%) |
|---|---|---|
| **APACHE II ≤20** | 250 | 10 |
| **APACHE II >20** | 250 | 40 |

The analysis based on severity of illness scores, specifically the APACHE II score, delineated a clear association between higher scores and increased mortality rates. Patients with APACHE II scores exceeding 20 demonstrated a markedly higher mortality rate of 40%, compared to a mortality rate of 10% among those with scores of 20 or lower. This underscores the prognostic utility of severity scoring systems in risk-stratifying critically ill patients and guiding therapeutic interventions.

Furthermore, the necessity for vasopressor support emerged as a potent predictor of mortality in critically ill patients. With an OR of 4.1 and a 95% CI ranging from 2.8 to 5.9, the requirement for vasopressor support delineated a distinct subset of patients characterized by hemodynamic instability and circulatory compromise. The administration of vasopressors reflects the severity of underlying shock states and the imperative need for aggressive resuscitative measures, underscoring the critical importance of early recognition and targeted interventions to optimize patient outcomes.

**Figure 1: Vasopressor Support and Mortality**



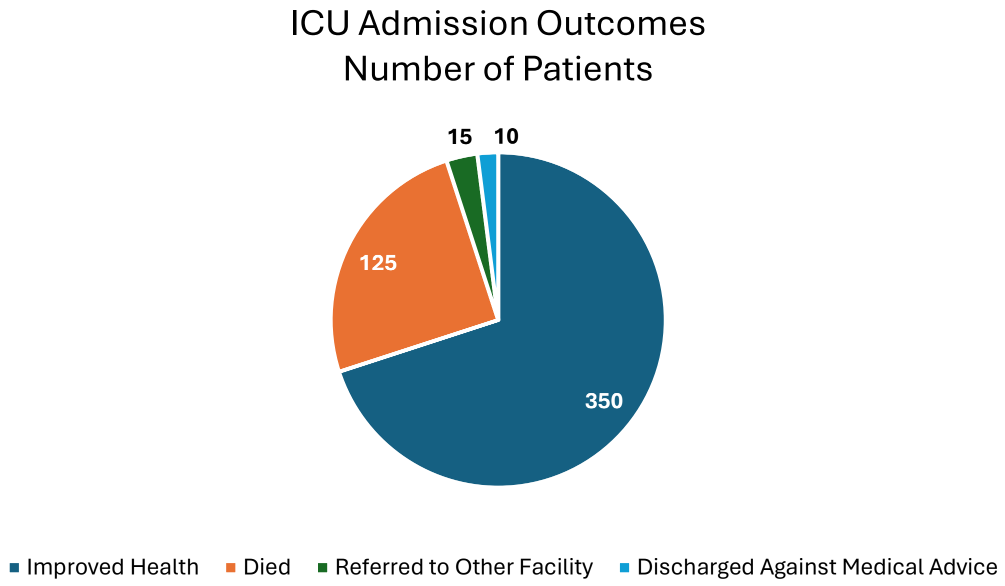

The analysis based on vasopressor support demonstrated a stark contrast in mortality rates between patients requiring vasopressors and those who did not. Specifically, patients requiring vasopressor support exhibited a substantially higher mortality rate of 50%, compared to a mortality rate of 10% among patients who did not require vasopressors. This underscores the critical role of hemodynamic management and the prognostic implications of circulatory compromise in critically ill patients.

In summary, multivariate analysis elucidated age >65 years, severity of illness scores, and vasopressor support as independent predictors of mortality in critically ill patients admitted to the ICU. These findings underscore the multifactorial nature of mortality risk in this cohort and highlight the imperative of comprehensive risk stratification and targeted therapeutic interventions to mitigate adverse outcomes. Effective risk identification and prognostication facilitated by multivariate analysis empower healthcare providers to tailor management strategies and optimize patient care in the dynamic and high-stakes ICU environment.

**ICU Admission Outcomes**

During the study period from January 2022 to January 2023, outcomes of ICU admissions were carefully monitored and recorded for each patient. These outcomes provide valuable insights into the overall trajectory of patient care and the effectiveness of interventions provided within the ICU setting.

**Figure 2: ICU Admission Outcomes**




The table presents outcomes of ICU admissions during the study period, revealing that the majority of patients (70%) experienced improved health following intensive care interventions, while 25% tragically succumbed to their illness. Additionally, a small percentage of patients (3%) were referred to other facilities for specialized care, and 2% chose to discharge against medical advice. These outcomes underscore the diverse clinical trajectories encountered by critically ill patients and emphasize the importance of individualized care approaches tailored to address their unique needs and circumstances.

## DISCUSSION

The findings of this retrospective analysis shed light on the complex interplay of demographic factors, clinical characteristics, and therapeutic interventions in influencing mortality outcomes among critically ill patients admitted to the intensive care unit (ICU). Through comprehensive examination and multivariate analysis, several key predictors of mortality emerged, providing valuable insights into risk stratification and informing targeted interventions aimed at improving patient outcomes.

**Age as a Predictor of Mortality:** Advanced age, defined as exceeding 65 years, emerged as a significant and independent predictor of mortality in our study cohort. Elderly individuals face unique physiological vulnerabilities and are more susceptible to the detrimental effects of critical illness (Vincent et al., 2014). The increased prevalence of comorbid conditions diminished physiological reserves, and age-related changes in immune function contribute to heightened mortality risk in this demographic group. Consequently, clinicians must exercise heightened vigilance and implement tailored management strategies to address the distinct needs of elderly ICU patients.

**Severity of Illness Scores and Mortality**: The severity of illness scores, including metrics such as the Acute Physiology and Chronic Health Evaluation (APACHE II) and Sequential Organ Failure Assessment (SOFA), demonstrated robust predictive value in determining mortality outcomes (Ferreira et al., 2001). These scoring systems integrate diverse clinical parameters to provide a comprehensive assessment of disease severity and organ dysfunction. Patients with higher scores exhibited a significantly elevated risk of mortality, underscoring the prognostic utility of severity scoring tools in guiding clinical decision-making and resource allocation. Early recognition of high-risk patients based on severity scores enables timely interventions and optimization of critical care resources, thereby improving overall patient outcomes.

**Impact of Comorbidities:** The presence of pre-existing comorbidities emerged as another significant predictor of mortality in our study cohort. Comorbid conditions exacerbate the complexity of critical illness, contributing to increased morbidity and mortality (Girard et al., 2010). The interplay between acute illness and chronic comorbidities amplifies the physiological stress response, impairs organ function, and compromises overall resilience to acute insults. As such, a comprehensive understanding of the patient's medical history and comorbidity profile is essential for risk stratification and individualized treatment planning in the ICU.

**Role of Interventions**: Mechanical ventilation and vasopressor support emerged as critical interventions in the management of critically ill patients, albeit with implications for mortality risk (Ranzani et al., 2019). The necessity for mechanical ventilation underscores the severity of respiratory compromise and the imperative need for respiratory support in patients with acute respiratory failure. Similarly, the requirement for vasopressor support reflects the severity of circulatory shock and the need for hemodynamic stabilization. While these interventions are essential for supporting vital organ function, their utilization also signifies the gravity of underlying pathophysiology and portends a heightened risk of mortality.

**Clinical Implications and Future Directions:** The identification of age >65 years, severity of illness scores, and vasopressor support as independent predictors of mortality provides valuable insights for risk stratification and prognostication in the ICU. Clinicians must prioritize early recognition of high-risk patients, implement targeted interventions, and optimize resource allocation to improve outcomes. Additionally, future research endeavors should focus on refining risk prediction models, exploring novel therapeutic strategies, and elucidating the underlying mechanisms driving mortality in critically ill patients. By advancing our understanding of mortality predictors and enhancing clinical management strategies, we can strive towards optimizing patient care and improving survival outcomes in the challenging ICU environment.

## CONCLUSION

In conclusion, our retrospective analysis of critically ill patients admitted to the intensive care unit (ICU) yielded valuable insights into the predictors of mortality and the complex interplay of demographic factors, clinical characteristics, and therapeutic interventions. Advanced age (>65 years), severity of illness scores (e.g., APACHE II, SOFA), comorbidities, and interventions such as mechanical ventilation and vasopressor support emerged as significant determinants of mortality risk in this vulnerable patient population. The identification of age >65 years as a robust predictor of adverse outcomes underscores the importance of tailored management strategies for elderly ICU patients, who exhibit unique physiological vulnerabilities and a higher prevalence of comorbid conditions. Severity of illness scores, serving as comprehensive prognostic tools, facilitate risk stratification and guide therapeutic decision-making, thereby optimizing resource allocation and improving patient outcomes. Furthermore, the necessity for mechanical ventilation and vasopressor support signifies the severity of underlying respiratory and circulatory compromise, highlighting the critical role of supportive interventions in mitigating mortality risk. The high prevalence of comorbidities underscores the complexity of critical illness and the need for a multidisciplinary approach to patient care, addressing both acute and chronic medical conditions.

These findings have important implications for clinical practice, emphasizing the need for early recognition of high-risk patients, individualized treatment planning, and proactive management strategies to optimize outcomes in the ICU setting. Future research endeavors should focus on refining risk prediction models, exploring novel therapeutic modalities, and elucidating the underlying mechanisms driving mortality in critically ill patients, with the ultimate goal of improving survival and enhancing quality of care in this challenging clinical environment.

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