

**Predictors of Adverse Outcome Early After ICU Stay****Rahul Kumar Joshi<sup>1</sup>, Divankur Khanna<sup>2</sup>, Amandeep Kaur<sup>3</sup>**<sup>1,2</sup>Assistant Professor, Department of Emergency Medicine and Critical Care, Maharshi Markandey Institute of Medical Science and Research, India<sup>3</sup>Amandeep Kaur, Senior Resident, Department of Anaesthesia, Maharshi Markandeya Institute of Medical Science and Research, India

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**Abstract:**

**Objective:** In order to mitigate potential complications and minimise the financial burden associated with an extended hospitalisation, medical practitioners often face the critical decision of determining the appropriate timing for discharging patients from the intensive care unit (ICU) environment. The primary aim of the present study was to ascertain potential risk factors associated with adverse outcomes in the immediate aftermath of intensive care unit (ICU) discharge or readmission.

**Methods:** Based on the patients' readmission status (Group A), mortality within 72 hours of ICU discharge (Group B), or absence of readmission or mortality within 72 hours (Group C), a total of 135 patients who were discharged from the intensive care unit (ICU) were categorised into three distinct outcome groups.

**Results:** In contrast to the cohort that achieved a favourable outcome subsequent to their discharge from the Intensive Care Unit (ICU), individuals who experienced readmission to the ICU exhibited significantly prolonged durations of hospitalisation in a general ward prior to their initial discharge. Patients who expired shortly after being discharged received vasopressor support without epinephrine for significantly extended durations and exhibited markedly more severe illnesses on the day of discharge. Individuals who experienced prolonged hospitalisation and received vasopressor therapy exhibited an increased susceptibility to early post-discharge mortality or readmission to the intensive care unit (ICU).

**Conclusion:** Patients who exhibit an extended length of hospitalisation and require vasopressor support are more susceptible to ICU readmission or mortality shortly after being discharged.

**Keywords:** Intensive Care Unit, Patient Readmission, Critically Ill, Early Discharge, Sepsis.

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**Introduction**

The intensive care unit (ICU) is a crucial element within the hospital setting, serving as a specialised facility that offers medical intervention to patients necessitating urgent attention, exhibiting severe illness, or presenting with the highest degree of instability. The medical conditions of these patients necessitate urgent intensive care unit (ICU) intervention. However, despite the presence of abundant healthcare facilities in certain regions, accessibility remains a challenge.

As a result of these inconsistencies, the timely provision of essential medical attention for these patients is postponed, potentially leading to their placement in general hospital wards until specialised facilities are accessible. We strongly advocate for expeditious admission to the Intensive Care Unit (ICU) due to the potential deleterious outcomes associated with any delays [1]. These medical conditions also entice certain patients to desire an early discharge from the intensive care unit (ICU), a decision that can lead to unfavourable outcomes,

deterioration of health, and subsequent readmission to the same medical facilities. Regrettably, the occurrence of readmission to the intensive care unit (ICU) within the same hospital admission has been correlated with an elevated probability of hospital mortality. This phenomenon has been postulated by certain scholars as a significant metric for assessing the provision of high-quality healthcare [2,3].

There is an increased susceptibility for complications to arise in patients of this nature, along with the potential for a delayed identification of clinical deterioration in these settings, should critically ill patients not receive the necessary level of care due to delays or premature discharges. Another noteworthy correlation is that a substantial portion of intensive care unit (ICU) survivors encounter novel physical disabilities and diminished capacity for activities of daily living subsequent to their stay in the ICU [9,10]. On the contrary, remarkably low rates of readmission may suggest that patients experienced challenges in being

discharged promptly, thereby resulting in a prolonged hospitalisation period. Consequently, healthcare professionals often face the decision-making process of determining the optimal timing for patient discharge, with the aim of delivering suitable medical care, mitigating the likelihood of patient readmission, and minimising unwarranted financial burden. Based on statistical data, it has been observed that approximately 10% of patients in affluent nations experience a recurrence of their hospitalisation, necessitating readmission to the intensive care unit within the same hospitalisation period [2,4]. In order to optimise patient care and hospitalisation in the intensive care unit (ICU), it is imperative to emphasise the crucial importance of being cognizant of factors associated with readmission and satisfactory ICU stays [5,6]. The objective of this study was to ascertain the potential risk factors associated with readmission and mortality subsequent to an early intensive care unit (ICU) discharge, with the aim of formulating a predictive framework for assessing discharge readiness and enhancing patient care.

### Materials & Methods

During a two-year period, a prospective study was conducted involving 157 patient participants in a hospital located in the Maharshi Markandeya Institute of Medical Science and Research. The subjects were closely monitored throughout their hospitalisation period and subsequent discharge from the Intensive Care Unit (ICU). The study was conducted solely in an observational manner, without any intervention-based procedures. As a result, informed consent was not obtained from the patients or their guardians. Based on the criteria of ICU readmission in group A, mortality within 72 hours following ICU discharge in group B, and survival beyond 72 hours in group C, the patients were stratified into three distinct cohorts. The data collected for each patient encompasses comorbidities, the primary reason for admission, physiological indicators (such as arterial blood pressure, heart rate, arterial blood gases), and laboratory measurements (including blood lactate, white blood cell count, WBC) upon admission and discharge from the intensive care unit (ICU). Additionally, the severity of illness is assessed using the APACHE II and SOFA scores, which evaluate acute physiology and chronic health status. The subsequent recording encompassed the consideration of various factors pertaining to

intensive care. The duration of hospitalisation (referred to as length of stay or LOS); acquisition of multidrug-resistant (MDR) organisms during intensive care unit (ICU) hospitalisation; the existence of a tracheostomy or central venous catheter (CVC) and the route of nutrition upon discharge; discharges occurring during afterhours (from 16:00 to 08:00 hours) and weekends; discharges within the hospital premises or outside; and the number of days a central venous catheter was in place.

### Statistical Analysis

There were two types of variables that exhibited an association with this particular dataset. Continuous variables were represented as mean  $\pm$  standard deviation (SD) or median, while the categorical variables were assessed using the Chi-square test. The application of one-way analysis of variance (ANOVA) was employed to evaluate and compare the continuous variables. Following the completion of the analysis of variance, which revealed a statistically significant difference, the Dunn's method or Holm-Sidak method was employed to conduct pairwise multiple comparison procedures. A p-value of less than 0.05 was deemed to indicate statistical significance, and all examinations were conducted with a two-tailed approach.

### Results

A total of 38 individuals (24.4%) from the study cohort, consisting of 157 patients who had been discharged from the Intensive Care Unit (ICU), Mortality rates subsequent to intensive care unit (ICU) discharge were observed to be 7.2% within a 72-hour timeframe and 17.2% within 28 days, as per the data gathered during the course of this study. Table 1 presents the anthropometric and clinical parameters of the study cohort. A similarity in the gender distribution and average age was observed following the categorization of patients into groups of three. The most prevalent primary admission diagnoses for all patients included acute respiratory failure, cardiac or neurological disorders, and sepsis. The study revealed a significant association between patients who experienced readmission to the Intensive Care Unit (ICU) and their prior prolonged duration of stay in the ward, in comparison to individuals who achieved favourable outcomes following their discharge from the ICU.

**Table 1: Anthropometric and clinical characteristics of study population**

Factor	Group A (n = 14)	Group B (n = 12)	Group C (n = 131)	p-value
Demographics				
Age (years) average	69	74	72	0.60
Male sex	10	10	87	0.051
Medical admission	8	12	84	0.071
Prior LOS in ward (days)	11	4	3	0.013

APACHE II	18.5 ± 5.3	23.7 ± 6.9	16.7 ± 7.9	0.18
SOFA	9	8	7	0.158
<b>Co morbidities</b>				
Diabetes mellitus	6	1	49	0.550
Chronic renal failure	2	2	22	0.750
Chronic lung disease	1	6	40	0.045
Chronic heart failure	5	1	26	0.109
Chronic neuro-psychiatric disorders	1	3	20	0.4
Immunosuppression	1	2	5	0.540

LOS: Length of Stay; APACHE: Acute Physiology and Chronic Health Evaluation; SOFA: Sequential Organ Failure Assessment

Regrettably, apart from the diminished prevalence of chronic pulmonary disease within the readmission cohort, the examination and assessment of comorbidities among the patients did not reveal substantial disparities.

Table 2 presents the risk factors associated with intensive care. Patients who expired shortly following their discharge were observed to have received prolonged administration of norepinephrine and vasopressor therapy in comparison to their counterparts. While it is important to acknowledge that this cohort exhibited an extended length of stay in the intensive care unit (ICU) and a prolonged duration of central venous catheterization, it is imperative to emphasise that these disparities did not attain statistical significance. There were several shared characteristics observed among the result groups in relation to the prevalence of tracheostomy, central venous catheterization (CVC), nasogastric feeding, and colonisation with a multidrug-resistant (MDR) organism upon discharge from the intensive care unit (ICU). The determination to release patients either to the inpatient setting or to the wards of alternative healthcare facilities exhibited minimal

influence on the final clinical prognosis. The study's analysis of readmission causes revealed that a significant proportion of patients who were readmitted to the Intensive Care Unit (ICU) were primarily attributed to sepsis. To provide a more accurate description, it should be noted that one patient presented with a challenging dermatological and subcutaneous tissue infection, while five patients necessitated readmission after undergoing emergency surgical procedures associated with their initial primary diagnosis.

Additionally, two patients experienced bloodstream infections attributed to catheter usage. The remaining patients were readmitted to the Intensive Care Unit (ICU) as a result of severe pulmonary edoema associated with ischemic heart disease, coma caused by hypoglycemia, acute respiratory failure, and neurologic impairment. The primary cause of early mortality subsequent to discharge from the intensive care unit (ICU) was severe respiratory failure, leading to the demise of a significant proportion of patients.

The remaining patients expired due to septic shock precipitated by a hematogenous infection caused by a multidrug-resistant (MDR) bacterium, followed by sudden cardiac arrest.

**Table 2: Intensive care-related risk factors of adverse outcome early after ICU discharge**

Factor	Group A (n = 14)	Group B (n = 12)	Group C (n = 131)	p-value
ICU LOS (days)	14	20	12	0.071
Length of CVC (days)	14	20	22	0.078
Length of MV (days)	9	12	8	0.42
Length of norepinephrine support (days)	6	14	4	0.011
CVVHDF	4	2	14	0.55
Tracheostomy	3	4	22	0.567
CVC	12	10	113	0.162
Nasogastric tube	7	9	59	0.130
Colonization with MDR pathogen	8	8	61	0.185
Weekday discharge	10	10	114	0.449
Morning shift discharge	11	11	99	0.570
In hospital discharge	12	7	87	0.523

LOS: Length of Stay; CVC: Central Venous Catheter. Table 3 presents the comprehensive

compilation of physical and laboratory parameters that exerted an influence on the day of discharge.

Based on the APACHE II calculation ( $13.5 \pm 3.9$  vs.  $9.6 \pm 4.4$ ,  $p = 0.007$ ), it was observed that patients who experienced mortality shortly after being discharged from the intensive care unit (ICU) exhibited significantly poorer disease status on the day of discharge in comparison to patients who did not require readmission.

However, the number of organ failures, as determined by the SOFA score calculation, was found to be similar between the two groups. Upon discharge, the respiratory and hemodynamic values

of the study groups exhibited similarity. The incidence of individuals exhibiting a Glasgow Coma Scale (GCS) score lower than 13 was significantly higher in Group B compared to Group A and Group C (7.7% vs. 36.4% vs. 8.45%,  $p = 0.014$ ). Among the three cohorts, there were no significant disparities observed in the blood lactate concentration (lac) levels and white blood cell (WBC) counts. The calculation was performed to determine the alteration in each variable upon admission to the Intensive Care Unit (ICU).

**Table 3: Physical and laboratory factors of study population on the discharge day**

Factor	Group A n=14	Group B n=12	Group C n=131	p-value
APACHE II (mean $\pm$ S.D.)	$10.5 \pm 4.1$	$12.5 \pm 2.9$	* $8.9 \pm 3.4$	0.008
SOFA	4	3	4	0.103
Systolic arterial pressure	116	120 (116-136)	130 (115-140)	0.677
Heart rate (bpm)	91	82	85	0.494
Glasgow Coma Scale (< 13)	2	5	12	0.015
PaO <sub>2</sub> /FiO <sub>2</sub> (mmHg)	$314 \pm 115$	$277 \pm 87$	$274 \pm 88$	0.331
Blood lactate concentration (mmol/L)	0.95	0.9	0.9	0.84
White blood cell count (cells/mcL)	9,500	9,290	10,545	0.981

## Discussion

Physicians currently rely on clinical judgement to determine the appropriate course of action for ICU discharge, as opposed to solely relying on objective standards. In the present investigation, we conducted a prospective study to examine various demographic, clinical, laboratory, and critical care factors that may influence an adverse outcome shortly following discharge from the intensive care unit (ICU).

The findings of our study are consistent with the results reported in previous research studies [2, 7]. It has been observed that individuals afflicted with chronic medical conditions who have experienced an extended duration of hospitalisation in the ward exhibit an increased probability of readmission or premature mortality. It is noteworthy to mention that individuals who expired within 72 hours following discharge had received vasopressor support for a significantly prolonged duration. This observation suggests that episodes of sepsis exhibited a prolonged resolution period.

Although the statistical significance of these differences was minimal, they did indicate a rise in intensive care unit (ICU) resource utilisation, as evidenced by extended ICU length of stay (LOS), central venous catheterization, and mechanical ventilation. The leading cause of mortality was determined to be respiratory failure, potentially precipitated by suboptimal pulmonary hygiene.

The readmission rate of our general Intensive Care Units (ICUs) was found to be 8.4%, a figure consistent with the range of values reported in previous review studies, which varied from 0.9% to 19% [2,7]. Based on the definitions provided by the

Surviving Sepsis Campaign [8], sepsis was identified as the principal cause for the patient's readmission.

Our study encountered certain limitations. The study conducted at a single medical facility raises the possibility that the management practises employed within the facility may have had an impact on the conclusions drawn from our findings. Additionally, the limited sample size within our study cohort may have impeded the attainment of statistical significance.

## Conclusion

In summary, the precise prognostication of variables associated with patients susceptible to readmission or premature mortality subsequent to intensive care unit (ICU) discharge continues to lack definitive evidence. According to prior studies, it has been indicated that a considerable proportion of readmissions, estimated to be around 40%, could potentially be linked to untimely discharge. The generalizability of these findings may be limited across various intensive care units (ICUs) due to variations in available resources and policies, particularly across different countries. The continued presence of organ dysfunction and the primary diagnosis for the patient's admission remain highly significant.

It remains challenging to accurately predict the likelihood of readmission or premature mortality following hospital discharge among patients. Individuals with heightened illness severity at the time of discharge, mildly compromised cognitive function, and particularly those with prolonged stays in the intensive care unit exhibit an increased susceptibility to premature mortality and necessitate

enhanced surveillance for clinical deterioration. Through the identification of these patients at high risk, it becomes possible to allocate additional resources, such as delayed discharge, specifically tailored to their needs.

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