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Clinical Characteristics of Patients Readmitted to the Medical ICU of a University Hospital and the Impact of Readmission on ICU Outcomes

Bedriye Sezer,[1] Kamil Inci,[2] Gulbin Aygencel,[2] Nazlihan Boyaci Dundar,[2] Melda Turkoglu[2]

Abstract

Aim: Intensive Care Unit (ICU) readmissions increase mortality and healthcare costs. Identifying high-risk patients is crucial for improving outcomes and optimizing resources. This study aimed to investigate the incidence, risk factors, and outcomes of unplanned readmissions in a medical ICU.

Study Design: This retrospective cohort study included adults admitted to the medical ICU of Gazi University between January 2018 and December 2019. Patients who stayed more than 24 hours were analyzed for ICU readmission during the same hospitalization after transfer to general wards or within 48 hours of discharge to home. Demographic, clinical, and laboratory variables were compared between readmitted and non-readmitted patients.

Results: Among 477 ICU admissions, 216 patients who died during the initial stay were excluded. Twenty-seven patients (10.3%) experienced unplanned readmission, while 234 comprised the non-readmission group. The overall ICU mortality during the initial admission was 45.3%. Among patients who survived their initial ICU stay, those who were readmitted had a higher ICU mortality rate (74.1%, p=0.028). Compared with the non-readmission group, readmitted patients more frequently had chronic kidney disease (CKD), malnutrition or impaired oral intake, limited mobilization, and pressure ulcers (p<0.05). They also had a higher requirement for noninvasive mechanical ventilation (NIMV) and high-flow nasal cannula therapy during their initial ICU stay (p<0.05). In multivariate analysis, CKD (odds ratio [OR]: 3.38, 95% confidence interval [CI]: 1.03–11.09), malnutrition or impaired oral intake (OR: 5.16, 95% CI: 1.32–20.17), and use of NIMV (OR: 5.08, 95% CI: 1.63–15.90) were independent predictors of ICU readmission.

Conclusions: These findings highlight potential targets for risk stratification, warranting validation in larger, multicenter studies.

Keywords: Critical care; Discharge; Intensive care; Readmission.

[1]*Department of Internal Medicine, Gazi University Faculty of Medicine, Ankara, Türkiye*
[2]*Department of Internal Medicine, Division of Critical Care, Gazi University Faculty of Medicine, Ankara, Türkiye*

Address for correspondence:
Kamil Inci, MD. Department of Internal Medicine, Division of Critical Care, Gazi University Faculty of Medicine, Ankara, Türkiye.
E-mail: kamilinci@gmail.com

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Introduction

Intensive care units (ICU) are specialized, technologically advanced hospital units staffed by highly trained personnel and designed to provide continuous observation and treatment for patients with life-threatening acute or chronic conditions affecting one or more organ systems. Due to the limited availability of ICU beds, the need for advanced equipment, and the requirement for specialized healthcare teams, ICU admissions are often guided by structured criteria to prioritize patients most likely to benefit from intensive care. However, compared to admission criteria, ICU discharge criteria are far less clearly defined.[1,2]

Even after being stabilized and transferred to wards, discharged home, or sent to long-term care facilities, patients may still develop complications, such as respiratory failure, infections, or gastrointestinal bleeding, that result in unplanned return to the ICU.[3] This event, defined as ICU readmission, typically refers to a patient's return to the ICU within a short time after discharge due to the same disease or its complications.[4] Previous studies have reported general ICU readmission rates of around 10%.[5] Hospital readmissions are frequently associated with patient frailty, progression of chronic disease, or suboptimal care during the preceding hospitalization, and may indicate an increased risk of adverse outcomes.[1] Moreover, ICU readmissions are linked to higher mortality and longer lengths of stay, highlighting their potential role as indicators of adverse outcomes and targets for quality improvement.[6]

Given the high financial and personnel demands of ICUs, understanding and preventing potentially avoidable ICU readmissions is a priority. Several studies have identified key risk factors associated with ICU readmission, including high initial Acute Physiology and Chronic Health Evaluation (APACHE II) and Sequential Organ Failure Assessment (SOFA) scores, multiple comorbidities, advanced age, prolonged mechanical ventilation, long ICU or hospital stays, early or premature discharge, and abnormal vital signs at the time of discharge.[5,7-10] Some research has emphasized that early readmissions, particularly those occurring within 48 hours of ICU discharge, may reflect premature or inappropriate discharges and could serve as a quality indicator for ICU care.[4,6,7]

Optimizing physiological parameters and organ function before ICU discharge, along with accurately identifying patients at risk of readmission, are considered critical strategies for reducing ICU readmission rates.[11] Furthermore, improved discharge planning, multidisciplinary coordination, and structured post-discharge follow-up may enhance outcomes and reduce preventable ICU returns.[12]

In this study, we aimed to evaluate ICU readmission rates, identify associated risk factors, and assess ICU mortality outcomes among patients readmitted to the medical ICU of a university hospital. By characterizing the clinical profiles of high-risk patients, we aim to develop improved discharge criteria and support interventions to reduce ICU readmission rates and improve patient safety.

Materials and Methods

Study Design and Ethical Approval

This study was designed as a retrospective, descriptive, and cross-sectional analysis conducted at Gazi University Hospital Medical ICU. Ethical approval was obtained from Gazi University Clinical Research Ethics Committee (Approval Number: 222, Date: 05.03.2020). All patient data were collected retrospectively from the hospital's electronic health record system and ICU patient charts, with strict adherence to confidentiality and ethical standards. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Study Population and Patient Selection

The study included adult patients (18 years or older) admitted to the Gazi University Hospital Medical ICU between January 1, 2018 and December 31, 2019, and who stayed in the ICU for at least 24 hours. A total of 477 patients met the inclusion criteria. ICU readmission was defined as an unplanned return to the ICU either during the same hospitalization after transfer to a general ward or within 48 hours of discharge home due to the same underlying illness or related complications.[13] Both in-hospital and early post-discharge readmissions were included in the analysis to comprehensively capture patient outcomes and identify risk factors.

Data Collection and Variables

Patient data were systematically retrieved from physician documentation, nursing records, and hospital electronic records. The collected variables included demographic data (age, sex); illness severity scores on ICU admission and at ICU discharge (APACHE II, SOFA,

Glasgow Coma Scale [GCS], and Risk, Injury, Failure, Loss of kidney function, and End-stage kidney disease [RIFLE]; pre-ICU hospital length of stay; presence of underlying comorbidities; causes of ICU admission; and type of clinic prior to ICU admission (emergency department, hospital wards, other hospitals, etc.). Additional clinical parameters recorded were oral intake status before ICU admission, mobility status, presence of pressure ulcers, Eastern Cooperative Oncology Group (ECOG) score, presence of sepsis or septic shock, microbiologically or radiologically confirmed infections, use of vasopressor support, antimicrobial therapies, presence and type of mechanical ventilation (MV) support, and complications developed during the ICU stay (e.g., acute kidney injury, acute respiratory distress syndrome, gastrointestinal bleeding, etc.). ICU outcomes, total ICU and hospital length of stay, vital signs at ICU discharge (temperature, heart rate, blood pressure, oxygen saturation), and timing of ICU discharge (weekday/weekend, working hours/out-of-hours) were also recorded. Laboratory parameters collected at ICU admission and discharge included complete blood counts, liver and kidney function tests, C-reactive protein (CRP), procalcitonin, and blood gas analyses.

For this study, data regarding malnutrition and impaired oral intake were retrospectively retrieved from medical records. During the study period, routine assessment of malnutrition and its risk in our ICU was performed using the Subjective Global Assessment (SGA) and documented in patients' medical records.[13] At ICU admission, medical history was obtained from the patient or, when necessary, from their relatives. Assessment included evaluation of weight changes, oral intake, gastrointestinal symptoms, and functional capacity. In addition, the presence of edema and ascites was assessed, subcutaneous fat and muscle status were examined, and body mass index (BMI) was calculated. In cases where a complete medical history could not be obtained, at minimum, information about oral intake during the preceding two weeks was sought from the patient, relatives, or, when transferred from another ward, the attending physician or nurse, to make an informed judgment. Recognizing that reduced oral intake alone is insufficient to define malnutrition or malnutrition risk, this distinction was specifically noted in the manuscript.

For patients with ICU readmission, additional data collected included reasons for readmission; clinical scores at readmission (APACHE II, SOFA, GCS, RIFLE, etc.); presence of sepsis or septic shock during the readmission episode; microbiological data; vasopressor use and duration; antimicrobial therapies administered; invasive device use; MV support and duration; complications during readmission; and ICU outcome after readmission. Comorbid chronic kidney disease (CKD) included all stages, including end-stage renal disease (ESRD). In contrast, within the RIFLE classification, the "E" category referred only to established ESRD.

Definition of Readmission

ICU readmission was defined as an unplanned return to the ICU either during the same hospitalization after transfer to a general ward or within 48 hours of discharge home, due to the same underlying illness or related complications.[14] Both in-hospital and early post-discharge readmissions were included in the analysis to comprehensively capture patient outcomes and identify risk factors.

Statistical Analysis

All statistical analyses were performed using SPSS version 22.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Kolmogorov-Smirnov test. Normally distributed continuous variables were expressed as means with standard deviations, whereas non-normally distributed continuous variables were reported as medians with interquartile ranges. Categorical variables were summarized as frequencies and percentages. Descriptive statistics were first generated for the overall patient cohort, followed by comparative analyses between the readmission and non-readmission groups. When appropriate, categorical variables were compared using the chi-square test or Fisher's exact test. The Mann-Whitney U test was applied to non-normally distributed continuous data, and the Student's t-test was used for normally distributed data. Variables identified as significant in univariate analyses were included in a multivariate logistic regression model to determine independent risk factors for ICU readmission. A p-value <0.05 was considered statistically significant.

Results

A total of 477 adult patients admitted to the medical ICU were included in the study. Patients who died during their initial ICU stay (n=216) were excluded from the analysis, as they had no risk of readmission (Table 1). Ultimately, 27 patients (10.3%) formed the readmission

Table 1. Comparison of patient characteristics, admission diagnoses, admission sources, and laboratory parameters at initial intensive care unit (ICU) admission between readmission and non-readmission groups

Characteristics	All Patients (n=477)	Readmitted (n=27)	Non-Readmitted (n=234)	p
Age (years) *	71 (60-80)	72 (60-81)	70 (55-79)	0.384
Male gender, n (%)	249 (52.2)	13 (48.1)	116 (49.6)	0.889
Comorbidities, n (%)	459 (96.2)	26 (96.3)	223 (95.3)	1
Hypertension	265 (55.6)	16 (59.3)	133 (56.8)	0.810
CAD/CHF	189 (39.6)	8 (29.6)	93 (39.7)	0.307
Diabetes mellitus	174 (36.5)	10 (37)	91 (38.9)	0.852
CKD/ESRD	132 (27.7)	13 (48.1)	55 (23.5)	0.006
Solid tumors	117 (24.5)	6 (22.2)	45 (19.2)	0.710
Asthma/COPD	107 (22.4)	3 (11.1)	61 (26.1)	0.087
Prior stroke/dementia	79 (16.6)	6 (22.2)	29 (12.4)	0.226
Pre-ICU characteristics, n (%)				
Malnutrition or impaired oral intake (n=470)	290 (60.7)	22 (84.6)	117 (50.4)	0.001
Limited mobility (n=471)	274 (58.2)	19 (73.1)	106 (45.7)	0.008
Immobile/bedridden (n=473)	56 (11.8)	2 (7.4)	20 (8.7)	1
Pressure ulcer (n=471)	267 (56.7)	18 (69.2)	102 (44)	0.014
Foley catheter/diaper use (n=470)	64 (13.6)	2 (8)	25 (10.8)	1
ECOG 0	3 (2.4)	0	2 (3.8)	0.784
ECOG 1	53 (41.7)	2 (40)	27 (50.9)	
ECOG 2	63 (49.6)	3 (60)	19 (35.8)	
ECOG 3	8 (6.3)	0	5 (9.4)	
APACHE II at admission*	22 (18-27)	19 (17-21)	19.5 (16-23)	0.560
SOFA at admission*	6 (4-9)	5 (4-9)	5 (3-8)	0.363
GCS at admission*	13 (8-15)	15 (13-15)	14 (11-15)	0.188
Pre-ICU hospital stay (days)*	3 (1-7)	3 (1-9)	2 (1-6)	0.210
AKI at admission, n (%)				
Risk (R)	113 (23.7)	5 (18.5)	53 (22.6)	0.625
Injury (I)	55 (11.5)	2 (7.4)	25 (10.7)	1
Failure (F)	81 (17)	5 (18.5)	35 (15)	0.579
Loss (L)	10 (2.1)	2 (7.4)	2 (0.9)	0.054
ESRD (E)	44 (9.2)	5 (18.5)	15 (6.4)	0.042
Reason for ICU admission, n (%)				
Sepsis/septic shock	350 (73.4)	19 (70.4)	137 (58.5)	0.302
Respiratory	334 (70)	16 (59.3)	146 (62.4)	0.751
Renal	232 (48.6)	16 (59.3)	100 (42.7)	0.102
Neurological/cognitive	79 (16.6)	6 (22.2)	30 (12.8)	0.232
Gastrointestinal	50 (10.5)	5 (18.5)	28 (12)	0.357
Cardiovascular	44 (9.2)	2 (7.4)	26 (11.1)	0.749
Source of ICU admission, n (%)				
Emergency department	264 (55.3)	11 (40.7)	140 (59.8)	0.057
Internal medicine wards	135 (28.3)	10 (37)	57 (24.4)	0.153
Other wards	42 (8.8)	3 (11.1)	21 (9)	0.723
Other ICUs	15 (3.1)	0	5 (2.1)	1

Table 1. Comparison of patient characteristics, admission diagnoses, admission sources, and laboratory parameters at initial intensive care unit (ICU) admission between readmission and non-readmission groups (Cont.)

Characteristics	All Patients (n=477)	Readmitted (n=27)	Non-Readmitted (n=234)	p
Laboratory parameters at ICU admission*				
Hemoglobin (g/dL)	10 (8.6-11.7)	8.8 (8-10.5)	10.3 (8.6-11.8)	0.013
White blood cell count (×10³/μL)	11.6 (8-16.3)	10.37 (6.97-16.2)	10.95 (7.79-15.4)	0.668
Neutropenia, n (%)	17 (3.6)	1 (3.7)	6 (2.6)	0.539
Platelet count (×10³/μL)	179 (117.5-256.5)	176 (129-261)	180 (126.7-249)	0.874
Blood urea nitrogen – BUN (mg/dL)	38 (22-62)	33 (19-49)	32 (20-54.5)	0.932
Serum creatinine (mg/dL)	1.42 (0.8-2.8)	1.5 (0.9-3)	1.29 (0.7-2.42)	0.399
Alanine aminotransferase (ALT) (U/L)	24 (12-61.2)	20 (10-50)	23 (12-53.5)	0.697
Total bilirubin (mg/dL)	0.8 (0.5-1.6)	1 (0.5-3.17)	0.8 (0.5-1.45)	0.182
Alkaline phosphatase (ALP) (U/L)	102 (73-164)	102 (69-188)	95 (69-142)	0.457
Serum albumin (g/dL)	2.7 (2.3-3.1)	2.6 (2.2-3.1)	2.85 (2.4-3.3)	0.018
Procalcitonin (ng/mL)	0.9 (0.2-4.3)	0.85 (0.33-2.7)	0.59 (0.23-2.77)	0.246
C-reactive protein – CRP (mg/L)	94 (33.5-170)	114 (40-188)	78.8 (20.5-149.5)	0.173
Serum sodium (mmol/L)	137 (133-141)	134 (130-139)	137 (133-141)	0.038
Serum potassium (mmol/L)	4 (3.5-4.6)	4 (3.4-4.7)	4 (3.5-4.6)	0.997
Phosphate (mg/dL)	3.7 (2.7-4.9)	3.1 (2.6-4.6)	3.6 (2.7-4.6)	0.574
Arterial pH	7.38 (7.31-7.44)	7.40 (7.33-7.48)	7.39 (7.33-7.45)	0.518
Partial pressure of O_2 (PaO_2) (mmHg)	69.9 (50.3-89.9)	66.5 (44.7-90.2)	67 (49.8-84.1)	0.861
Partial pressure of CO_2 ($PaCO_2$) (mmHg)	33 (27-41)	30.9 (27.8-36.2)	33.7 (28-42.4)	0.451
Serum lactate (mmol/L)	1.6 (1.1-2.4)	1.2 (0.9-1.8)	1.4 (0.9-2.2)	0.262

*Data are presented as median (interquartile range). ICU: Intensive care unit; CAD/CHF: Coronary artery disease/Congestive heart failure; CKD/ESRD: Chronic kidney disease/End-stage renal disease; COPD: Chronic obstructive pulmonary disease; ECOG: Eastern Cooperative Oncology Group performance status; GCS: Glasgow Coma Scale; AKI: Acute kidney injury; APACHE II: Acute Physiology and Chronic Health Evaluation II; SOFA: Sequential Organ Failure Assessment; ICU: Intensive Care Unit. Limited mobility: Defined as partial dependence for ambulation. Impaired oral intake: Includes clinically or functionally impaired swallowing and/or reduced oral intake.

group, while 234 patients who survived without requiring ICU readmission comprised the non-readmission group (Table 1). The ICU mortality rate during the initial admission was 45.3%. Among patients who survived their initial ICU stay, those who were readmitted had a significantly higher ICU mortality rate (74.1%, p=0.028).

There were no significant differences between the readmission and non-readmission groups in terms of age, sex, or admission severity scores, including performance status before ICU, APACHE II, SOFA, and GCS scores (p>0.05 for all) (Table 1). The readmission group had a significantly higher prevalence of chronic kidney disease (48.1% vs. 23.5%, p=0.006), malnutrition or impaired oral intake (84.6% vs. 50.4%, p=0.001), limited mobilization (73.1% vs. 45.7%, p=0.008), and pressure ulcers on ICU admission (69.2% vs. 44%, p=0.014) compared with the non-readmission group.

Initial ICU admission diagnoses were predominantly sepsis/septic shock (73.4%), respiratory failure (70.0%), and renal complications (48.6%), with no statistically significant differences between the groups (p>0.05) (Table 1). Microbiological data revealed that gram-positive pathogens were more frequently identified in the readmission group compared with the non-readmission group (40.7% vs. 23.1%, p=0.044) (Table 2). During the initial ICU stay, the readmission group had a higher requirement for noninvasive mechanical ventilation (NIMV) (44.4% vs. 23.5%, p=0.018) and high-flow nasal cannula (HFNC) therapy (18.5% vs. 5.1%, p=0.021) (Table 3). At discharge, the readmission group had a higher SOFA score [3 (3-6) vs. 3 (1-5), p=0.026], higher median heart rate on the day of discharge [92 (81.5-99.5) vs. 87 (75-96), p=0.044], and a greater proportion of weekend discharges (6 (22.2%) vs. 19 (8.1%), p=0.018) compared with the non-readmission group (Table 4). Several laboratory values were associated with readmission risk. At initial ICU admission, the readmission group had lower hemoglobin [8.8 (8-10.5) vs. 10.3 (8.6-11.8), p=0.013], albu-

Table 2. Comparison of sepsis, infection source and pathogen, initiated antimicrobials, invasive device use, respiratory support, and major issues at initial intensive care unit (ICU) admission between readmission and non-readmission groups

Parameters	All Patients (n=477)	Readmitted (n=27)	Non-Readmitted (n=234)	p
Sepsis/Septic Shock, n (%)	350 (73.4)	19 (70.4)	137 (58.5)	0.236
Infection Source, n (%)				
Pulmonary	192 (40.3)	8 (29.6)	59 (25.2)	0.619
Bloodstream/Catheter	140 (29.4)	10 (37)	61 (26.1)	0.225
Urinary Tract	101 (21.2)	7 (25.9)	41 (17.5)	0.297
Intra-abdominal	32 (6.7)	3 (11.1)	16 (6.8)	0.428
Wound/Surgical Site	21 (4.4)	2 (7.4)	6 (2.6)	0.196
Vasopressor Support, n (%)	147 (30.8)	8 (29.6)	57 (24.4)	0.549
Microbiological Pathogens, n (%)				
Gram-Negative Bacteria	145 (30.4)	9 (33.3)	52 (22.2)	0.196
Gram-Positive Bacteria	133 (27.9)	11 (40.7)	54 (23.1)	0.044
Fungal Pathogens	46 (9.6)	2 (7.4)	11 (4.7)	0.631
Viral Pathogens	15 (3.1)	2 (7.4)	5 (2.1)	0.156
Initiated Antimicrobial Agents, n (%)				
Gram-Positive Coverage	426 (89.3)	25 (92.6)	194 (82.9)	0.272
Gram-Negative Coverage	420 (88.1)	25 (92.6)	190 (81.2)	0.186
Antifungal Agents	60 (12.6)	5 (18.5)	22 (9.4)	0.174
Antiviral Agents	56 (11.7)	4 (14.8)	28 (12)	0.755
Invasive Devices, n (%)	428 (89.7)	22 (81.5)	209 (89.3)	0.213
Urinary Catheter	369 (77.4)	18 (66.7)	175 (74.8)	0.363
Central Venous Catheter	202 (42.3)	11 (40.7)	90 (38.5)	0.818
Endotracheal Tube	141 (29.6)	4 (14.8)	50 (21.4)	0.426
Tracheostomy	5 (1)	0	4 (1.7)	1
Mechanical Ventilation and Oxygen Therapy, n (%)	394 (82.6)	21 (77.8)	178 (76.1)	0.843
IMV	145 (30.4)	4 (14.8)	53 (22.6)	0.351
NIMV	72 (15.1)	5 (18.5)	31 (13.2)	0.553
HFNC	1 (0.2)	0 (0)	1 (0.4)	1
Duration of Respiratory Support Before ICU (days)*	1 (0.6-3)	1 (0-5)	1 (0-2)	0.431
AKI at ICU Admission, n (%)	259 (54.3)	13 (48.1)	118 (50.4)	0.823
ARDS at ICU Admission, n (%)	19 (4)	0	2 (0.9)	1
Gastrointestinal Bleeding at ICU Admission, n (%)	17 (3.6)	2 (7.4)	7 (3)	0.236
Cardiac Arrest at ICU Admission, n (%)	38 (8)	1 (3.7)	5 (2.1)	0.484
Stroke/CVE at ICU Admission, n (%)	5 (1)	0	1 (0.4)	1

*Data are presented as median (interquartile range). ICU: Intensive Care Unit; IMV: Invasive Mechanical Ventilation; NIMV: Noninvasive Mechanical Ventilation; HFNC: High-Flow Nasal Cannula; AKI: Acute Kidney Injury; ARDS: Acute Respiratory Distress Syndrome; CVE: Cerebrovascular Event.

min [2.6 (2.2-3.1) vs. 2.85 (2.4-3.3), p=0.018], and sodium [134 (130-139) vs. 137 (133-141), p=0.038] levels. At discharge, lower hemoglobin [8.7 (7.6-10.7) vs. 9.5 (8.6-11.2), p=0.050], albumin [2.6 (2.2-2.8) vs. 2.7 (2.4-3.1), p=0.032], and phosphorus [3 (2.1-3.6) vs. 3.4 (2.7-4.3), p=0.035], as well as higher total bilirubin [1.35 (0.6-2.6) vs. 0.8 (0.5-1.5), p=0.043] and lactate [1.7 (1.1-2) vs. 1.2 (0.8-1.7), p=0.047] levels, were observed in the readmission group.

In multivariate analysis, CKD (odds ratio [OR]: 3.38, 95% confidence interval [CI]: 1.03-11.09), malnutrition or impaired oral intake (OR: 5.16, 95% CI: 1.32-20.17), and use of NIMV (OR: 5.08, 95% CI: 1.63-15.90) were identified as independent predictors of ICU readmission (Table 5). Regarding model performance, the logistic regression model demonstrated a Nagelkerke R^2 of 0.38. The Hosmer-Lemeshow goodness-of-fit test yielded a p-value of 0.67.

Table 3. Sepsis episodes, infection characteristics, use of invasive devices, respiratory support, and clinical complications during the initial intensive care unit (ICU) stay among readmission and non-readmission groups

Parameters	All Patients (n=477)	Readmitted (n=27)	Non-Readmitted (n=234)	p
Sepsis/Septic Shock, n (%)	225 (47.2)	9 (33.3)	55 (23.5)	0.261
Infection Source, n (%)				
Pulmonary	147 (30.8)	5 (18.5)	28 (12)	0.357
Bloodstream/Catheter	86 (18)	2 (7.4)	22 (9.4)	1
Urinary Tract	63 (13.2)	3 (11.1)	18 (7.7)	0.464
Intra-abdominal	18 (3.8)	0	6 (2.6)	1
Wound/Surgical Site	10 (2.1)	1 (3.7)	2 (0.9)	0.280
Vasopressor Support, n (%)	236 (49.5)	7 (25.9)	51 (21.8)	0.625
Identified Pathogens, n (%)				
Gram-Negative Bacteria	125 (26.2)	6 (22.2)	26 (11.1)	0.117
Gram-Positive Bacteria	78 (16.4)	2 (7.4)	24 (10.3)	1
Fungal Pathogens	72 (15.1)	1 (3.7)	17 (7.3)	0.704
Viral Pathogens	7 (1.5)	0	2 (0.9)	1
Initiated Antimicrobial Agents, n (%)				
Gram-Positive Coverage	239 (50.1)	13 (48.1)	74 (31.6)	0.085
Gram-Negative Coverage	228 (47.8)	10 (37)	69 (29.5)	0.419
Antifungal Agents	96 (20.1)	1 (3.7)	23 (9.8)	0.485
Antiviral Agents	21 (4.4)	0	7 (3)	1
Invasive Devices, n (%)	459 (96.2)	26 (96.3)	218 (93.2)	1
Urinary Catheter	415 (87)	21 (77.8)	190 (81.2)	0.669
Central Venous Catheter	327 (68.6)	12 (44.4)	119 (50.9)	0.528
Endotracheal Tube	248 (52)	5 (18.5)	60 (25.6)	0.418
Tracheostomy	29 (6.1)	0	11 (4.7)	0.611
Mechanical Ventilation and Oxygen Therapy, n (%)	424 (88.9)	22 (81.5)	189 (80.8)	0.929
IMV	263 (55.1)	8 (29.6)	67 (28.6)	0.914
NIMV	127 (26.6)	12 (44.4)	55 (23.5)	0.018
HFNC	28 (5.9)	5 (18.5)	12 (5.1)	0.021
Duration of Respiratory Support in ICU Stay (days)*	5 (2-11)	5 (1-7)	3 (1-7)	0.836
AKI During ICU Stay, n (%)	298 (62.5)	12 (44.4)	122 (52.1)	0.449
RRT	205 (43)	12 (44.4)	67 (28.6)	0.090
Intermittent RRT	166 (34.8)	12 (44.4)	63 (26.9)	0.057
Continuous RRT	80 (16.8)	1 (3.7)	11 (4.7)	1
ARDS During ICU Stay, n (%)	35 (7.3)	1 (3.7)	4 (1.7)	0.423
GI Bleeding During ICU Stay, n (%)	26 (5.5)	1 (3.7)	8 (3.4)	1
Cardiac Arrest During ICU Stay, n (%)	59 (12.4)	0	3 (1.3)	1
Stroke/CVE During ICU Stay, n (%)	1 (0.2)	0	1 (0.4)	1

*Data are presented as median (interquartile range). ICU: Intensive Care Unit; IMV: Invasive Mechanical Ventilation; NIMV: Noninvasive Mechanical Ventilation; HFNC: High-Flow Nasal Cannula; AKI: Acute Kidney Injury; RRT: Renal Replacement Therapy; ARDS: Acute Respiratory Distress Syndrome; GI: Gastrointestinal; CVE: Cerebrovascular Event.

Discussion

In this retrospective cohort study, we found an ICU readmission rate of 10.3% among patients who survived their initial stay in a university medical ICU. ICU readmission was independently associated with CKD, malnutrition or impaired oral intake, and the use of NIMV during the initial ICU stay. Notably, the overall ICU mortality rate during the initial admission was 45.3%, while mortality among patients who required ICU readmission was significantly higher, at 74.1%.

Table 4. Comparison of prognostic scores, vital signs, discharge timing, and laboratory parameters between readmission and non-readmission groups at intensive care unit (ICU) discharge

Parameters	All Patients (n=477)	Readmitted (n=27)	Non-Readmitted (n=234)	p
SOFA at ICU Discharge*	3 (1-5)	3 (3-6)	3 (1-5)	0.026
GCS at ICU Discharge*	15 (15-15)	15 (14-15)	15 (15-15)	0.213
RIFLE at ICU Discharge, n (%)				
Risk (R)	81 (17)	2 (7.4)	49 (20.9)	0.092
Injury (I)	49 (10.3)	2 (7.4)	20 (8.5)	1
Failure (F)	99 (20.8)	3 (11.1)	16 (6.8)	0.428
Loss (L)	29 (6.1)	1 (3.7)	9 (3.8)	1
ESRD (E)	47 (9.9)	6 (22.2)	15 (6.3)	0.013
Vital Signs at ICU Discharge* (n=244)				
Body Temperature (°C)	36.5 (36.3-36.5)	36.5 (36.3-36.6)	36.4 (36.3-36.5)	0.249
Heart Rate (beats/min)	87 (76-96)	92 (81.5-99.5)	87 (75-96)	0.044
Respiratory Rate (breaths/min)	20 (18-24)	20 (18-26)	21 (18-24)	0.674
Mean Arterial Pressure (mmHg)	82 (73.3-91.3)	79.3 (71.3-89.4)	82 (73.3-92)	0.202
Oxygen Saturation (%)	94 (92-97)	95 (93-97)	94 (92-97)	0.330
Time (Extubation-ICU Discharge, days)*	4 (2-8)	7 (1-8)	4 (2-8)	0.889
Time (Vasopressor Discontinuation-ICU Discharge, days)*	3 (1-7)	2.5 (1.75-4.75)	3 (1-7.5)	0.932
Discharge Day/Time, n (%)				
Weekend Discharge	70 (14.7)	6 (22.2)	19 (8.1)	0.018
Out-of-Hours Discharge	204 (42.8)	10 (37)	60 (25.6)	0.206
Laboratory Parameters at ICU Discharge* (n=244)				
Hemoglobin (g/dL)	9.1 (8.1-10.4)	8.7 (7.6-10.7)	9.5 (8.6-11.2)	0.050
White Blood Cell Count (×10³/μL)	10.9 (7.1-14.6)	8.5 (5.3-12.2)	9.4 (6.4-12.5)	0.465
Neutropenia, n (%)	18 (3.9)	1 (3.7)	8 (3.5)	1
Platelet Count (×10³/μL)	163 (72.2-246)	140 (55-274)	189 (132-269)	0.125
Blood Urea Nitrogen – BUN (mg/dL)	41 (25-64)	31 (22-50)	34 (19-50.5)	0.873
Serum Creatinine (mg/dL)	1.4 (0.8-2.7)	1.1 (0.8-2.3)	1 (0.6-1.9)	0.277
Alanine Aminotransferase (ALT) (U/L)	28 (14-69.2)	22 (13-44)	25 (13-56)	0.505
Total Bilirubin (mg/dL)	1.1 (0.5-2.2)	1.35 (0.6-2.6)	0.8 (0.5-1.5)	0.043
Alkaline Phosphatase (ALP) (U/L)	120 (80-194)	117 (63-216)	103 (73.5-150.7)	0.486
Serum Albumin (g/dL)	2.40 (2.1-2.8)	2.6 (2.2-2.8)	2.7 (2.4-3.1)	0.032
Procalcitonin (ng/mL)	0.9 (0.2-4.3)	0.45 (0.12-2.43)	0.3 (0.1-1.2)	0.248
C-reactive Protein – CRP (mg/L)	78.7 (29.2-135)	81.5 (24.2-176)	57.8 (18.6-111)	0.072
Serum Sodium (mmol/L)	137 (134-142)	136 (133-141)	137 (134-141)	0.383
Serum Potassium (mmol/L)	4 (3.5-4.5)	3.8 (3.3-4.3)	3.8 (3.4-4.3)	0.941
Phosphate (mg/dL)	3.7 (2.8-4.8)	3 (2.1-3.6)	3.4 (2.7-4.3)	0.035
Arterial pH	7.38 (7.30-7.44)	7.43 (7.33-7.48)	7.42 (7.37-7.47)	0.854
Partial Pressure of O_2 (PaO_2) (mmHg)	65.3 (43.1-87.9)	56.2 (37.1-81.9)	59 (40.1-76)	0.919
Partial Pressure of CO_2 ($PaCO_2$) (mmHg)	35.1 (30-42)	37.6 (31.1-43.3)	35.6 (31-41.5)	0.514
Serum Lactate (mmol/L)	1.7 (1.1-3.1)	1.7 (1.1-2)	1.2 (0.8-1.7)	0.047

*Data are presented as median (interquartile range). ICU: Intensive Care Unit; SOFA: Sequential Organ Failure Assessment; GCS: Glasgow Coma Scale; RIFLE: Risk, Injury, Failure, Loss, End-stage kidney disease; ESRD: End-Stage Renal Disease.

Our findings on ICU readmission rate align with prior studies reporting ICU readmission rates between 5% and 15%, with strong links to increased mortality, prolonged hospital stays, and greater resource utilization.[15-18] The observed mortality rate of over 70% among readmitted patients in our cohort corroborates previous reports that identified advanced age and early readmission as significant contributors to mortality.[18]

Table 5. Multivariate analysis of independent risk factors for intensive care unit (ICU) readmission

Risk Factors	Wald Score	p	Odds Ratio (95% Confidence Interval)
Presence of CKD/ESRD	4.022	0.045	3.377 (1.028-11.094)
Malnutrition or impaired oral intake at ICU admission	5.573	0.018	5.163 (1.321-20.174)
Use of NIMV during the initial ICU stay	7.816	0.005	5.084 (1.626-15.898)
SOFA score at ICU discharge	1.340	0.247	1.145 (0.910-1.440)
Heart rate at ICU discharge (beats/min)	3.332	0.068	1.037 (0.997-1.078)
Hemoglobin at ICU admission (g/dL)	2.385	0.123	0.785 (0.577-1.067)
Serum albumin at ICU admission (g/dL)	0.040	0.842	0.920 (0.403-2.100)
Serum sodium at ICU admission (mmol/L)	3.179	0.075	0.934 (0.867-1.007)
Serum lactate at ICU discharge (mmol/L)	2.007	0.157	1.665 (0.822-3.371)
Serum phosphate at ICU discharge (mg/dL)	2.865	0.091	0.650 (0.395-1.070)
Weekend ICU discharge	0.149	0.699	0.747 (0.170-3.278)

ICU: Intensive Care Unit; CKD: Chronic Kidney Disease; ESRD: End-Stage Renal Disease; NIMV: Noninvasive Mechanical Ventilation; SOFA: Sequential Organ Failure Assessment.

Comorbidities played a critical role in readmission risk in our study. CKD was independently associated with ICU readmission, supporting evidence that impaired renal function predisposes patients to clinical instability after ICU discharge.[17-19] Because CKD is frequently accompanied by fluid and electrolyte imbalances and reduced physiological reserve, these patients may benefit from closer follow-up and proactive post-discharge management.

Another significant finding was the association between malnutrition, impaired oral intake, and ICU readmission risk, underlining the broader role of nutritional status in critical care outcomes. Although often underassessed, this finding aligns with previous evidence suggesting that frailty markers, including malnutrition and impaired mobility, contribute to worse post-ICU outcomes.[20-22]

We also observed a significantly higher use of NIMV and HFNC during the initial ICU stay among the readmission group. These modalities are standard in the management of acute respiratory failure, particularly in conditions such as exacerbations of chronic obstructive pulmonary disease (COPD) and decompensated heart failure, where patients generally experience better ICU outcomes compared with the broader medical ICU population.[23,24] This discrepancy may reflect the heterogeneity of our cohort and the limited sample size. Alternatively, patients who required NIMV or HFNC may have had borderline respiratory stability or chronic conditions, such as advanced COPD or heart failure, that were not fully resolved at discharge. In some cases, noninvasive support may also have been chosen for frail or elderly patients as part of a more conservative treatment approach, avoiding intubation. These factors may help explain the higher readmission rates observed in this group, positioning NIMV use as a marker of underlying fragility rather than a direct cause of readmission. Taken together, while our findings point to a potential link between initial non-invasive respiratory support and ICU readmission, the clinical heterogeneity of our cohort and the relatively small number of readmission events limit the ability to draw definitive conclusions. Thus, this finding should be interpreted with caution and warrants further investigation in larger, more homogeneous populations.

Weekend discharges were more common in the readmission group, supporting previous reports that off-hour discharges may compromise the transition of care.[24,25] This finding may be explained by the fact that weekend transitions may be associated with reduced availability of senior staff, limited access to diagnostic and therapeutic procedures, and potential gaps in coordination with receiving wards. These organizational factors may contribute to a higher risk of clinical deterioration after transfer. Although causality cannot be established, our results suggest that careful patient selection and enhanced support during weekend discharges could help mitigate readmission risk. Similarly, elevated SOFA scores and higher heart rates at ICU discharge were significantly associated with readmission, reinforcing the role of sustained organ failure and physiological instability as warning signs.[18,26,27]

Several laboratory abnormalities were also more prevalent in the readmission group at discharge, including lower hemoglobin, albumin, sodium, and phosphorus levels, alongside higher total bilirubin and lactate. These markers may not reflect acute instability on their own; instead, they could be residual indicators of incomplete clinical recovery or chronic organ dysfunction that persisted after ICU discharge. For instance, persistent anemia and hypoalbuminemia have been linked to poorer outcomes in ICU survivors in previous studies.[28] Likewise, elevated lactate or a high lactate/albumin ratio is an established predictor of in-hospital mortality in critically ill patients, suggesting that unresolved metabolic stress may predispose patients to deterioration after ICU discharge.[29] Therefore, rather than acting as direct causative factors, these values may function as adjunctive markers within broader risk stratification models. Given our cohort's heterogeneity and the small size of the readmission group, these associations remain exploratory. Future studies with larger and more uniform patient populations are needed to determine whether these laboratory parameters can reliably refine discharge readiness and predict post-ICU outcomes.

Interestingly, several variables traditionally considered predictive of ICU outcomes, such as APACHE II and SOFA scores on admission, pre-ICU hospital length of stay, ICU admission source, and the presence of acute kidney injury (AKI), did not differ significantly between the readmission and non-readmission groups in our study. The lack of association with initial APACHE II and SOFA scores may reflect comparable disease severity at admission in both groups. These results suggest that factors related to clinical and physiological status at discharge, rather than at admission, may play a more decisive role in readmission risk. Similarly, the lack of an association between pre-ICU hospital stay or admission source and readmission risk may reflect the limited number of readmitted patients. The absence of a significant relationship between AKI or elevated inflammatory markers and readmission risk could be attributed to their transient nature or successful resolution during the initial ICU stay. Alternatively, our findings may have been influenced by the modest sample size and diagnostic heterogeneity, which could have limited the statistical power to detect smaller effect sizes. Although not conclusive, these non-significant results underscore the complexity of ICU readmission risk and the need to consider a broader range of clinical and functional parameters beyond traditional severity scores.

Our study highlights the importance of careful planning and individualized risk assessment in ICU patients before discharge. Incorporating markers such as renal dysfunction, nutritional status, and physiological parameters may improve prediction of patients at risk for readmission. Structured post-discharge follow-up and continuity-of-care protocols may also help prevent potentially avoidable ICU returns.

This study has several limitations. First, its retrospective, single-center design may limit the generalizability of the findings. Second, certain potentially relevant variables such as frailty scores, cognitive status, delirium, and post-discharge follow-up practices were not systematically recorded and therefore could not be analyzed. Third, although multivariate regression analysis was performed, unmeasured confounding factors may still exist. Lastly, the small number of patients in the readmission group may have affected the statistical power and limited subgroup analyses.

Conclusion

Unplanned ICU readmission remains a serious event associated with high mortality and clinical deterioration. Identifying high-risk patients, particularly those with CKD, malnutrition, and NIMV dependence, offers an opportunity to improve outcomes through targeted interventions and optimized discharge practices. Future prospective, multicenter studies are warranted to validate these findings and guide the development of predictive models and standardized discharge criteria.

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