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Characteristics and Outcome of ICU Unplanned Readmission in Trauma Patients During the Same Hospitalization

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ABSTRACT

Objective: This study aimed to determine the rate of readmission for trauma patients in ICUs, as well as the factors that predict this outcome.
Methods: This retrospective cohort study was conducted at Emtiaz Hospital, a level I referral trauma center (Shiraz, Iran). It analyzed the ICU readmission rates among trauma patients over three years. The required data were extracted from the Iranian Intensive Care Registry (IICUR), which included patient demographics, injury severity, physiological parameters, and clinical outcomes. Statistical analysis was performed using SPSS version 25.0. Descriptive statistics and different statistical tests, such as T-tests, Mann-Whitney tests, Chi-square tests, and logistic binary regression test were utilized.
Results: Among the 5273 patients discharged from the ICU during the study period, 195 (3.7%) were readmitted during the same hospitalization. Patients readmitted to the ICU had a significantly higher mean age (54.83±22.73 years) than those who were not readmitted (47.08 years, $p<0.001$). Lower Glasgow Coma Scale (GCS) scores at admission and discharge were associated with ICU readmission, implying that neurological status and readmission risk were correlated with each other. Furthermore, respiratory challenges were identified as the leading cause of unexpected readmission, including respiratory failure, hypoxic respiratory failure, respiratory distress, and respiratory infections such as pneumonia. Injury patterns analysis revealed a higher frequency of poly-trauma and head and neck injuries among patients readmitted to the ICU.
Conclusion: This study underscored the importance of ICU readmission among trauma patients, with a high readmission rate during the same hospitalization. By developing comprehensive guidelines and optimizing discharge processes, healthcare providers could potentially mitigate ICU readmissions and associated complications, ultimately enhancing patient outcomes and resource utilization in trauma ICU settings. This research provided valuable insights to inform evidence-based practices and improve the quality of care delivery for trauma patients in intensive care settings.

Keywords: Trauma, Readmission, Intensive care unit, Predictor, Prognosis.

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Introduction

One of the main challenges in the healthcare system is patient readmission to intensive care units (ICUs) [1]. The readmission of trauma patients to the ICU poses various challenges for healthcare systems, such as longer hospital stays, increased risks of complications, higher healthcare expenses, and a worsened prognosis for patients readmitted to the ICU [1-3]. Readmission to ICUs is one of the key indicators of quality evaluation of therapeutic centers to enhance patient outcomes and optimize resource usage [2, 4]. Several predictors of ICU readmission have been identified, including age, the number of comorbidities, the severity of injury, and marital status [5-8]. Moreover, the most common risk factors identified in the ICU readmission studies were respiratory and cardiovascular disorders at the time of discharge. Furthermore, discharging patients during night shifts, lack of standard protocols for the discharge process, poor coordination, ICU bed limitation, and delay in discharge were reported as other factors contributing to ICU readmission [9, 10]. Despite this evidence, a previous review study found that the available surveys had relatively low predictive accuracy for readmission. [11] This dearth of evidence is particularly pronounced in the realm of trauma patients, where the readmission rate to ICUs is still high [3, 12-15]. Therefore, this study aimed to determine the rate of readmission for trauma patients in ICUs, as well as the factors that predict this outcome. The results of this research can be used by managers and policymakers to guide decisions on trauma patients in ICUs.

Material and Methods

This retrospective cohort study was conducted at Emtiaz Hospital, a level I referral trauma center with five ICUs and a post-ICU in Shiraz, Iran. This study evaluated all trauma patients readmitted to the ICUs of this trauma center between March 2019 and August 2022 (Figure 1).

This survey included trauma patients over the age of 18 who were admitted to the ICUs, except for those admitted for less than four hours and burn patients. Patients were discharged from the ICU according to protocol when they no longer required respiratory support, advanced monitoring, or special nursing care, and had normal hemodynamics. If a patient in the ward required respiratory support, advanced monitoring, special nursing care, or abnormal hemodynamics, they would be readmitted to the ICU at the discretion of the intensivist.

This study employed a checklist as a data collection tool, which included patient identification, injury mechanism, physiological status, injury severity, hospitalization outcomes in ICUs and hospitals, level of consciousness, ICU stay duration, Glasgow Coma Scale (GCS) at discharge, and use of inotropes and vasopressors. The data were obtained from the Iranian Intensive Care Unit Registry (IICUR), a Persian ICU-based registry established in 2018 at Nemazee Hospital, affiliated with Shiraz University of Medical Sciences (Shiraz, Iran). This registry was developed based on the COMET (CORE Outcome Measurement and Evaluation Tool) program, following the approval

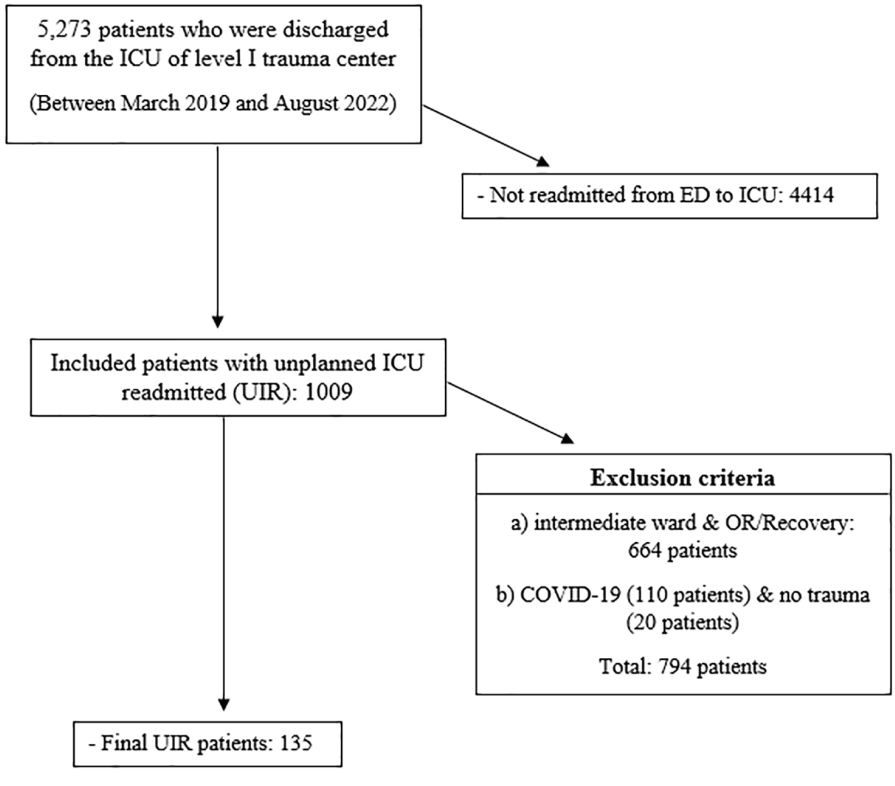

Figure 1. Patient inclusion/exclusion.

of the Australian and New Zealand Intensive Care Society. IICUR was approved by the Ethics Committee of Shiraz University of Medical Sciences in 2018 (IR.SUMS.REC.1397.559) and recognized by the Iran Ministry of Health as the first and only registry of adult ICU in Iran. Since 2019, this registry has been implemented in the ICUs at Emtiaz Hospital in Shiraz and contains information on all patients admitted to these units. The mechanism of trauma was collected from the patient's records.

The analysis was conducted using descriptive statistics including mean, standard deviation, percentage, and frequency. For quantitative data, T-tests were applied if the data was normally distributed, while the Mann-Whitney test was used for non-normally distributed data. The qualitative data was analyzed using the Chi-square test. Logistic binary regression was employed to determine predictors of ICU readmission. A p-value<0.05 was considered statistically significant. All statistical analyses were performed using SPSS software version 25.0.

Results

Out of the 5273 patients discharged from the ICU, 195 patients (3.7%) were readmitted. The mean age of all patients was 47.36±21.70 years. Patients who were readmitted to the ICU had a significantly higher mean age than those who were not readmitted (54.83±22.73 vs 47.08±21.60; p<0.001) (Table 1).

This study found that the most of patients were men (79.6%) and were transferred from the emergency

Table 1. Characteristics of traumatic patients who are non-readmitted and unplanned readmitted to ICU

Characteristic	All Patients (n=5273)	Non readmitted (n=5078)	ICU unplanned Readmitted (n=195)	*p* value
Age, years, mean SD	47.36±21.70	47.08±21.60	54.83±22.738	<0.001
Sex, n (%)				0.12
Male	4195 (79.60)	4051 (79.80)	144 (73.80)	
Female	1077 (20.4)	1026 (20.20)	51 (26.20)	
Initial ICU Admission source, n (%)				<0.001
OR/Recovery	1682 (31.90)	1630 (32.10)	52 (26.70)	
Emergency department	3196 (60.60)	3081 (60.70)	115 (59.00)	
Ward	331 (6.30)	313 (6.20)	18 (9.20)	
Other ICUs, the same hospital	61 (1.20)	51 (1.00)	10 (5.10)	
Other hospital	0 (0.00)	0 (0.00)	0 (0.00)	
ICU, other hospital	3 (0.10)	3 (0.10)	0 (0.00)	
Tracheostomy, n (%)	495 (9.50)	456 (9.1)	39 (20.1)	<0.001
Mechanical ventilation, n (%)	2653 (100.00)	2537 (100.00)	116 (100.00)	0.75
Renal Replacement Therapy, n (%)	85 (1.60)	80 (1.60)	5 (2.60)	0.28
Inotropes /vasopressor, n (%)	460 (8.80)	437 (8.70)	23 (11.90)	0.12
GCS Score at Admission	13.40±1.95	13.15±2.31	12.51±2.59	0.02
GCS Score at Discharge	13.76±1.43	13.71±1.45	13.06±2.07	<0.001
GCS Discharge Eye, n (%)				<0.001
Do not open	570 (12.10)	539 (11.90)	31 (18.2)	
Open to pain	182 (3.90)	170 (3.80)	12 (7.10)	
Open to Voice	713 (15.20)	671 (14.80)	42 (24.70)	
Open spontaneously	3227 (68.80)	3142 (69.50)	85 (50.00)	
GCS Discharge Motor, n (%)				<0.001
No response	438 (9.30)	427 (9.40)	11 (6.50)	
Extends	24 (0.50)	22 (0.50)	2 (1.20)	
Decorticate flexion	49 (1.00)	42 (0.90)	7 (4.10)	
Flexion-withdrawal	57 (1.20)	48 (1.10)	9 (5.30)	
Localizes	226 (4.80)	204 (4.50)	22 (12.90)	
Obeys commands	3898 (83.10)	3779 (83.60)	119 (70.00)	
GCS Discharge Verbal, n (%)				<0.001
No Response	60 (1.60)	55 (1.50)	5 (4.70)	
Incomprehensible Sounds	130 (3.50)	122 (3.40)	8 (7.50)	
Inappropriate Words	576 (15.40)	554 (15.30)	22 (20.60)	
Confused	2017 (54.00)	1958 (38.60)	59 (55.10)	
Orientated	951 (25.50)	938 (18.50)	13 (12.10)	
Initial ICU discharge Time, n (%)				0.25
7-13:59 (Morning)	2020 (38.30)	1875 (38.50)	65 (33.30)	
14-19:59 (Evening)	2320 (44.00)	2133 (43.80)	93 (47.70)	
20-06:59 (Night)	933 (17.70)	858 (17.60)	37 (19)	

SD: Standard deviation; ICU: Intensive Care Unit; OR: Operation Room; ISS: Injury Severity Score; IQR: Inter-quartile Range; APACHE II: Acute Physiology and Chronic Health Evaluation II; GCS: Glasgow Coma Scale; Level of significance was p<0.05.

department to the ICU (60.6%). The majority of patients (90.5%) did not require tracheostomy, renal replacement therapy (98.4%), or inotropes/vasopressors (91.2%). Patients who were readmitted to the ICU during hospitalization had a lower GCS score upon hospital admission than those who were not readmitted (12.51±2.59 vs 13.15±2.31; p=0.02). This result was the same regarding the GCS score at the time of discharge from the first ICU hospitalization. The scores were 13.06±2.07 in the readmitted group and 13.71±1.45 in the non-readmitted group (p<0.001). The majority of patients had a spontaneously open state for eye GCS (68.8%), obeyed commands for motor GCS (83.1%), and were confused for verbal response GCS (54%). Most patients (44%) were discharged from the ICU in the afternoon (Table 1).

Patients who were readmitted to the ICU had significantly different sources of ICU admission, tracheostomy, ocular, motor, and language GCS at discharge than those who were not (p<0.001). Sex did not differ significantly between the two groups (p=0.12). Additionally, there were no significant differences in terms of mechanical ventilation (p=0.75), renal replacement therapy (p=0.27), and inotrope/vasopressor (p=0.12) between patients with and without ICU readmission. Table 1 presents the demographics and characteristics of all patients, including those with and without ICU readmission.

The findings indicated that patients who were readmitted to the ICU had a significantly higher median hospitalization length than those who were not readmitted (4.93 days [IQR=8.33] vs. 3.37 days [IQR=5.26]; P<0.001). Table 2 presents the results for patients with and without ICU readmission, showing a significant disparity in ICU and hospital mortality rates (p<0.001). It is worth mentioning that of the 195 patients readmitted to the ICU, 41 (21%) died.

Table 3 provides a detailed breakdown of the reasons for unplanned readmission in the traumatic ICU. The most prevalent causes were respiratory issues, including respiratory failure, hypoxic respiratory failure, respiratory distress, and respiratory system infections such as pneumonia, which accounted for 42.1% of cases. Furthermore, the results indicated that poly-trauma and head and neck injuries were the most frequent types of injuries among traumatic patients readmitted to the ICU, with rates of 63.6% and 24.1%, respectively (Table 4).

Discussion

The research findings indicated that trauma patients in the ICU had a readmission rate of 3.7% during the same hospitalization. A previous survey investigated

Table 2. Outcomes of traumatic patients who are not readmitted and readmitted to ICU

Characteristic	All Patients (N=5273)	Non readmitted (N=5078)	ICU unplanned Readmitted (N=195)	*p* value
Initial ICU LOS, Median (IQR)	3.43 (5.46)	3.37 (5.26)	4.93 (8.33)	<0.001
ICU outcome, n (%)				<0.001
Dead	41 (0.70)	0 (0.00)	41 (21)	
Alive	5232 (99.20)	5078 (100.00)	154 (79)	
Hospital outcome, n (%)				<0.001
Dead	600 (12.00)	542 (11.20)	58 (31.50)	
Alive	4414 (88.00)	4288 (88.70)	126 (68.50)	

ICU LOS: Intensive care unit Length of Stay; IQR: Inter-quartile Range; ICU: Intensive Care Unit. The level of significance was p<0.05.

Table 3. Cause of unplanned readmission in traumatic ICU

Cause of unplanned readmission	Frequency
Pneumonia and Respiratory failure or respiratory distress or hypoxic respiratory failure	82 (42.1)
Neurologic disease	36 (18.5)
Acute Myocardial Ischemia or Cardiac arrest	33 (16.9)
Gastrointestinal disease	20 (10.3)
Unknown	17 (8.7)
Hospital-acquired infections	7 (3.6)
Total	195 (100.0)

Table 4. Body region injuries of traumatic patients unplanned readmission in ICU

Body region injury	Frequency
Multiple Trauma	124 (63.6)
Head or Neck	47 (24.1)
Extremities or pelvic girdle	15 (7.7)
Face	3 (1.5)
Chest	3 (1.5)
Abdominal or pelvic contents	3 (1.5)
Total	195 (100.0)

various adult ICU readmissions and found readmission rates ranging from 1.3% to 13.7% [3]. Variations in ICU readmission rates across different patient populations, including surgical, medical, neonatal, and general ICUs, contributed to these differences. Specifically, for trauma patients, the ICU readmission rate was 3.6% in North Carolina [16], 4.5% in South Carolina, 5.6% in the USA overall [17], and 11.5% in Georgia [7].

An increase in ICU readmission has negative consequences. Patients who require readmission to ICUs experienced longer hospital and ICU stays than those who did not require readmission [16, 18]. Despite ICU beds making up a small portion of total hospital beds, they contribute significantly to hospital costs, accounting for 20-30% of total expenses [16]. By reducing the rate of ICU readmissions and subsequently decreasing the number of hospital days, the financial burden on both patients and hospitals could be alleviated. Studies consistently showed that readmitted patients had higher in-hospital and ICU mortality rates than non-readmitted patients [19, 20]. For instance, a study in Brazil found that ICU readmission patients had approximately three times higher in-hospital mortality rates than those without readmissions [1], a trend that was also observed in the present study.

A review study identified age as the primary factor leading to re-admission of trauma patients to the ICU [19]. Other research reported that older age was associated with higher rates of ICU readmission in trauma patients [7, 16, 17]. These findings were consistent with those of the present study. It is recommended that patients at risk of ICU re-admission, based on their age and physical condition, should be transferred to step-down units or long-term acute care hospitals instead of ordinary wards.

The present study found a correlation between the initial admission source of patients and their likelihood of being readmitted to the ICU, which was consistent with previous research [1, 3, 21]. Patients admitted from the operating room/recovery room or transferred from another hospital had a higher rate of readmission, as seen in a similar study [7].

The rate of readmission to the ICU is determined by several factors, including the level of consciousness [7, 22, 23]. The findings of the present study demonstrated that lower GCS scores at the time of initial hospitalization in the ICU and also at the time of discharge increased the chance of readmission. The present study also found that patients with tracheostomy had a higher rate of readmission.

Patients are often discharged from the ICU during the day shift; however, in rare circumstances, due to a lack of ward capacity, the patient might be discharged during the night shift. While some studies found a correlation between night shift and off-hour discharges to higher ICU readmission rates [3], others found no such correlation [22]. Implementing a standardized discharge process, utilizing skilled ICU consultation teams, and providing support to ward staff in managing critically ill patients could help reduce readmission rates. Interventions such as intensive care transfer programs could improve clinical transfer between the ICU and the ward, ultimately reducing the risk of readmission [24, 25]. Additionally, a study in the USA found that delaying ICU discharge by more than 24 hours could significantly decrease the likelihood of readmission compared to early discharge [17].

The reason for readmission to ICU is one of the impressive factors determining the rate of readmission, which was consistent with the findings of the present study [26]. The most common cause of readmission among traumatic patients in the study was respiratory challenges, such as distress and failure. This could be attributed to overlooking certain diagnostic criteria, suboptimal monitoring of breathing status in traumatic patients, and defects in pulmonary rehabilitation programs.

The present study also revealed that polytrauma was the most common type of injury among readmitted trauma patients. Polytrauma is a complex injury that might be accompanied by other situations such as ineffective non-operative management, exacerbation of injuries, management of underlying medical conditions affecting the injury, or missed injuries, all of which could increase the likelihood of readmission in traumatized patients [27].

In most previous studies, men [1, 6, 22, 23], respiratory complications and duration of utilizing mechanical ventilation and non-invasive ventilation [23], vasopressors requirement [1], and use of renal replacement therapy during ICU stay [1, 6] were found to be associated with more ICU readmissions. However, in the present study, there was no significant difference in sex, ventilation condition, renal replacement therapy, and inotrope/vasopressor use between patients without readmission and those with ICU readmission.

Since this study was conducted in a single trauma center, it might not reflect the situation in other centers, which could be one of the limitations of the present study. Although many indicators were included in the study, some factors could not be explored; since this study was retrospective, and we had limited data access.

This study highlighted the importance of ICU readmissions in trauma patients, particularly the high rate of readmissions within the same hospitalization. Higher age, admission source, tracheostomy, and level of consciousness were predictors of ICU readmission. By implementing thorough guidelines and improving discharge procedures, healthcare professionals would have the opportunity to reduce ICU readmissions and related complications. The findings of this research could offer valuable information for supporting evidence-based strategies and enhancing the quality of care provided to trauma patients in ICUs.

Declaration

Ethics approval and consent to participate: This study was approved by the institutional review board of Shiraz University of Medical Science (Approval ID: IR.SUMS.REC.1401.334)

Consent for publication: Not applicable.

Conflict of Interest: The authors declared no conflict of interest.

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