Predictors of early ICU re-admission, a retrospective observational case-control study

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Abstract

Aim
This study aimed to identify predictors of early ICU re-admission following discharge, considering the multifaceted nature of this phenomenon.

Methods
This retrospective observational case-control study was conducted, involving 51 patients (27 cases, 24 controls). The study assessed various parameters, including admission source, specialty, APACHE II scores, mechanical ventilation, vasopressor support, and CRRT. Data were collected at primary admission, discharge, and re-admission.

Results
The analysis revealed statistically significant associations between early re-admission and mechanical ventilation [71.4% of cases (n=20) versus 45.8% of controls (n=11), p = 0.039], vasopressor support [77.8% of cases (n=22) versus 50% of controls (n=12), p = 0.038], predicted mortality [Median predicted mortality was 25.5 for cases and only 7 for controls, p = 0.038], and length of stay [Median length of stay was 9.5 days for cases and 4 days for controls, p = 0.028]. Discharging patients on enteral nutrition significantly increased the likelihood of early re-admission [70.4% of cases (n=19) were discharged on enteral nutrition while only 20.8% of controls (n=5) were discharged on enteral nutrition, p<0.001]. Higher early warning scores at discharge were also linked to increased re-admission risk [Median early warning score was 6 in cases and 4 in controls, p = 0.016].

Discussion
These findings underscore the importance of considering multiple clinical and physiological parameters in assessing and managing patients at risk for early ICU re-admission. The study contributes valuable insights for enhancing patient care and optimising discharge decision-making

processes. However, this study is preliminary, highlighting the necessity for a larger case cohort and recommending a multicentre approach to validate and broaden the findings.

Introduction

Unplanned early ICU readmission is associated with increased mortality, and prolonged hospital and ICU stays.[1] That is why it is important to trace risk factors predisposing to re-admission.

ICU re-admission may happen due to an unpredictable event after ICU discharge, or an incorrect clinical decision in discharging a patient who is not yet ready for ward transfer.[2]

Unplanned early readmission to ICU is an important indicator to assess the quality of care in the ICU. In November 2022, the National Office of Clinical Audit (NOCA) published the 2020 annual report of the Irish national ICU audit which revealed that overall rates of unplanned readmission to ICUs in 2020 were 1.0%.[2]

There has been great interest in the literature on ICU re-admission prediction. Multiple scoring systems have been created over the past years, however, there was wide heterogeneity in the nature of the chosen parameters among them.

In 2008, the stability and workload index for transfer score identified ICU admission source, ICU length of stay, and day of discharge neurologic and respiratory impairment, as predictors of re-admission to ICU.[3] On the other hand, Xue et al. used temporal trends of physiological and medication variables to set up their proposed score.[4] While Fialho et al. advised that the highest predictive power for readmission was achieved when calculating the mean of physiological and laboratory parameters during the last 24 hours before discharge; namely, heart rate, temperature, arterial blood pressure, SPO2, platelet count, and serum lactate.[5]

Variations among previously proposed prediction scoring systems and their relative complexity have led to difficulty in adopting a clear prediction model for re-admission to ICU in our hospital. That's why we found it essential to study our ICU patients for possible factors that could lead to early re-admission after discharge from ICU.

Methods

This retrospective observational case-control study investigated the patients who were admitted to our ICU within the timeframe from January 2021 to March 2023.

Cases included patients more than 18 years old who were re-admitted within 48 hours of their discharge from our ICU, while controls were randomly chosen to match study cases in their number, age, gender, and time frame of admission.

We excluded individuals aged 18 years and below, those discharged to another hospital, patients with one-way discharge decisions (deemed not for ICU re-admission), and those who died during ICU stay.

The study conducted a thorough review of patient parameters at different stages of care. During the primary admission, factors including the source of admission, medical specialty, APACHE II score, predicted mortality, length of stay, and the need for interventions like mechanical ventilation, vasopressor support, or CRRT were examined.

At the time of discharge after the primary ICU stay, the study assessed the early warning score, discharge with tracheotomy, type of nutritional support, timing of discharge (daytime or out-of-hours), and the destination of discharge (ward versus HDU).

Upon re-admission, the investigation delved into the reason for re-admission, whether cardiopulmonary resuscitation was administered prior to re-admission, the APACHE II score at re-admission, predicted mortality, and the ultimate outcome, distinguishing between discharge alive or deceased.

Data collection was based on the internal hospital electronic patient records.

Data analysis was performed using the software SPSS (Statistical Package for the Social Sciences) version 26. Categorical variables were described using their absolute frequencies and were compared using the chi-square test, Fisher exact and Monte Carlo tests when appropriate. The Shapiro-Wilk test was used to verify assumptions for use in parametric tests. Quantitative variables were described using their means and standard deviations or median and interquartile range according to the type of data. To compare quantitative data between two groups, the independent sample t-test (for normally distributed data) and Mann-Whitney test (for not normally distributed data) were used. Binary logistic regression was used to identify independent risk factors associated with certain health problems. The level of statistical significance was set at $P < 0.05$. A highly significant difference was present if $p \leq 0.001$.

Results

The study included 51 patients; 27 patients in the study group and 24 patients in the control group. Both groups matched their baseline characteristics. (Table 1)

Table (1) Comparison between the studied groups regarding baseline data:

	Case group N=27	Control group N=24	χ^2	p
Gender: Female Male	10 (37%) 17 (63%)	10 (41.7%) 14 (58.3%)	0.114	0.735
≥2 comorbidity	14 (51.9%)	18 (75%)	2.913	0.088
	Mean ± SD	**Mean ± SD**	t	p
Age (year)	59.33 ± 16.15	61.29 ± 16.22	-0.431	0.668

χ^2 Chi-square test   t independent sample t-test

Upon analysing patients' data during their primary admission, a statistically significant relationship was found between early re-admission and all of the mechanical ventilation (MV) (p = 0.039), vasopressor support (p = 0.038), predicted mortality (p = 0.038), and length of stay (p = 0.028). On the other hand, the difference between the studied groups regarding the source from which the patient was referred, specialty, APACHE II on admission, and the need for CRRT was statistically non-significant. (Table2)

Table (2) Comparison between the studied groups regarding data on primary admission:

	Case group N=27	Control group N=24	χ^2	p
Source:				
CCU	1(3.7%)	0 (0%)		
ED	4 (14.8%)	8 (33.3%)		
Other hospital	3 (11.1%)	0 (0%)	MC	0.196
Theatre	10 (37%)	11 (45.8%)		
Ward	9 (33.3%)	5 (20.8%)		
Specialty:				
Cardiology	0 (0%)	1 (4.2%)		
Colorectal surgery	0 (0%)	1 (4.2%)		
ENT	1 (3.7%)	1 (4.2%)		
Gastro	3 (11.1%)	0 (0%)		
General medicine	1 (3.7%)	3 (12.5%)		
General surgery	1 (3.7%)	4 (16.7%)	MC	0.235
ID	1 (3.7%)	0 (0%)		
Neurosurgery	6 (22.2%)	4 (16.7%)		
Oncology	0 (0%)	1 (4.2%)		
Orthopedics	1 (3.7%)	0 (0%)		
Renal	3 (11.1%)	1 (4.2%)		
Respiratory	4 (14.8%)	4 (16.7%)		
UGI	2 (7.4%)	2 (8.3%)		
Urology	0 (0%)	2 (8.3%)		
Vascular	4 (14.8%)	0 (0%)		
MV	20 (71.4%)	11 (45.8%)	4.251	0.039*
Vasopressor	21 (77.8%)	12 (50%)	4.293	0.038*
CRRT	5 (18.5%)	3 (12.5%)	Fisher	0.707
	Mean ± SD	**Mean ± SD**	t	p
APACHE II	18.59 ± 6.69	15.57 ± 7.99	1.459	0.151
	Median (IQR)	**Median (IQR)**	Z	p
Predicted mortality (%)	25.5(6 − 65.75)	7(1.5 − 30)	-2.079	0.038*

Length of stay (day)	9.5(4 – 21)	4(3 – 9)	-2.202	0.028*

χ² Chi-square test   t independent sample t-test   MC Monte Carlo test   Z Mann Whitney test   IQR interquartile range   *p<0.05 is statistically significant   **p≤0.001 is statistically highly significant

There was a highly statistically significant relation between early re-admission and the type of nutrition at the time of primary discharge from ICU (70.4% of those who needed early re-admission versus 20.8% of those who did not need early re-admission were discharged on enteral nutrition) (p<0.001). Moreover, early warning scores at the time of primary discharge were significantly higher in those who needed early re-admission (p = 0.016).

However, there were no significant differences in having tracheostomy, discharge time, or destination after discharge between the groups. (Table3)

Table (3) Comparison between the studied groups regarding data at discharge from primary admission:

	Case group N=27	Control group N=24	χ²	p
Tracheostomy	7 (25.9%)	3 (12.5%)	Fisher	0.3
Nutrition Enteral Oral TPN	19 (70.4%) 6 (22.2%) 2 (7.4%)	5 (20.8%) 17 (70.8%) 2 (8.3%)	MC	<0.001**
Discharge time: Day time Out of hours	14 (51.9%) 13 (48.1%)	13 (54.2%) 11 (45.8%)	0.027	0.869
Destination: CCU Ward	3 (11.1%) 24 (88.9%)	0 (0%) 24 (100%)	Fisher	0.238
	Median (IQR)	**Median (IQR)**	**Z**	**p**
Early warning score	6(3.5 – 9)	4(1.75 – 6)	-2.406	0.016*

χ² Chi-square test   t independent sample t-test   MC Monte Carlo test   Z Mann Whitney test   IQR interquartile range   *p<0.05 is statistically significant   **p≤0.001 is statistically highly significant

As regards the cause of early re-admission, one-third of patients were re-admitted as a consequence of shock, and the same percentage of cases were admitted due to respiratory failure. The mean APACHE II on readmission was 22.41 (±9.36). Median predicted mortality was 23%. (Table4)

Table (4) Comparison between the studied groups regarding the reason for re-admission-related data:

	Case group N=27
Cause of re-admission:	
Cardiogenic shock	1 (3.7%)
Liver cell failure	1 (3.7%)
Lower limb ischemia	1 (3.7%)
Postcardiac arrest	2 (7.4%)
Postoperative	2 (7.4%)
Respiratory failure	9 (33.3%)
Seizures	1 (3.7%)
Shock	9 (33.3%)
Sepsis	1 (3.7%)
	Mean ± SD
APACHE II	22.41 ± 9.36
	Median (IQR)
Predicted mortality	23(8.25 − 88.5)

Regarding outcome after re-admission, survival rates among re-admitted patients did not significantly differ based on gender, comorbidity, source of admission, specialty, MV, vasopressor support, tracheostomy, CRRT, age, APACHE II score, or early warning score. However, significant associations were found between outcome and predicted mortality on readmission (p = 0.012). (Table5)

Table (5) Outcome of patients who needed early re-admission:

	Survivors N=20	Non-survivors N=7	χ^2	p
Gender:				
Female	6 (30%)	4 (57.1%)	Fisher	0.365
Male	14(70%)	3 (42.9%)		
≥2 comorbidity	9 (45%)	5 (71.4%)	1.451	0.228
Source:				
CCU	1 (5%)	0 (0%)		
ED	2 (10%)	2 (28.6%)		
Other hospital	1 (5%)	2 (28.6%)	MC	0.259
Theatre	8 (40%)	2 (28.6%)		
Ward	8 (40%)	1 (14.3%)		
Specialty:				

ENT	1 (5%)	0 (0%)		
Gastro	2 (10%)	1 (14.3%)		
General medicine	1 (5%)	0 (0%)		
General surgery	0 (0%)	1 (5%)		
ID	1 (5%)	0 (0%)		
Neurosurgery	5 (25%)	1 (14.3%)	MC	0.815
Orthopedics	1 (5%)	0 (0%)		
Renal	3 (15%)	0 (0%)		
Respiratory	2 (10%)	2 (28.6%)		
UGI	1 (5%)	1 (14.3%)		
Vascular	3 (15%)	1 (5%)		
MV	14 (70%)	6 (85.7%)	Fisher	0.633
Vasopressor	15 (75%)	6 (85.7%)	Fisher	0.656
Tracheostomy				
CRRT	3 (15%)	2 (28.6%)	Fisher	0.58
	Mean ± SD	**Mean ± SD**	t	p
Age (year)	57.55 ± 16.27	64.43 ± 15.83	-0.969	0.342
APACHE II	17.4 ± 5.83	22.0 ± 8.27	-1.613	0.119
	Median (IQR)	**Median (IQR)**	**Z**	**p**
Predicted mortality (%)	12(4.25 – 47.25)	63(32 – 78)	2.398	0.014*
Length of stay (day)	14.5(3.75 – 33)	11(9 – 12)	-0.464	0.651
Early weaning score	5.67 ± 2.66)	8 ± 2.71	-1.962	0.062

χ^2 Chi-square test   t independent sample t-test   MC Monte Carlo test   Z Mann Whitney test
IQR interquartile range   *p<0.05 is statistically significant   **p≤0.001 is statistically highly significant

Discussion:

In this retrospective observational case-control study aimed at identifying predictors of early ICU re-admission, a comprehensive analysis of various parameters was undertaken. The findings shed light on crucial factors that contribute to the likelihood of early re-admission after discharge from the intensive care unit.

Our study underscored the significant impact of mechanical ventilation (MV) and vasopressor support on the probability of early re-admission. Patients who required MV and received vasopressor support during their initial ICU stay exhibited a significantly higher risk of early re-admission. Moreover, higher predicted mortality and longer length of stay during the primary admission were associated with increased chances of early re-admission.

Discharging patients on enteral nutrition compared with normal oral nutrition emerged as a significant factor in early re-admission. Additionally, higher early warning scores upon discharge

from the primary admission were linked with an increased likelihood of early re-admission, indicating the predictive value of this scoring system in identifying patients at risk.

It is crucial to acknowledge that the study's limitation lies in the relatively small number of cases involved. As such, this serves as a preliminary investigation, and there is a pressing need for expansion to a larger cohort of cases. Furthermore, to enhance the generalisability of the findings, future research should consider a multicentre approach rather than a single-centre focus. These steps are imperative to validate and extend the current study's findings, ultimately contributing to a more comprehensive understanding of the multifaceted nature of early re-admission to the ICU.

Declaration of conflict of interest:
None declared.

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