Original Article

Access this article online
Quick Response Code:

Website:
https://eurasianjpulmonol.org
DOI:
10.14744/ejp.2022.4001

Prediction of pulmonary intensive care unit readmissions with Stability and Workload Index for Transfer score

Özlem Ertan, Deniz Çelik[1], Murat Yıldız, Hasret Gizem Kurt

ORCID:
Özlem Ertan: 0000-0002-1530-6999
Deniz Çelik: 0000-0003-4634-205X
Murat Yıldız: 0000-0002-9625-9994
Hasret Gizem Kurt: 0000-0001-5504-122X

Abstract:

BACKGROUND AND AIM: Readmission of patients discharged from the intensive care unit (ICU) to the ICU is common and increases mortality. The Stability and Workload Index for Transfer (SWIFT) score is a scoring system developed and validated to predict the risk of readmission to the ICU. We evaluated the usability of this scoring system in patients with respiratory failure in a pulmonary intensive care unit (PICU).

METHODS: This study was a retrospective cross-sectional study that included patients hospitalized in the PICU between January 1, 2020, and December 31, 2020. Patients who were discharged to the clinic or home and readmitted in the first 7–30 days were included in the study. Patients referred to an upper-level ICU or another hospital and those who died in the hospital were excluded from the study.

RESULTS: A total of 442 patients received inpatient treatment during the study period, and 421 patients were included. Eight (1.9%) patients were readmitted within the first 7 days, and 25 (5.9%) patients were readmitted within 7–30 days. There was no significant difference between the SWIFT score, Acute Physiology and Chronic Health Evaluation II (APACHE II), and modified Charlson Comorbidity Index (mCCI) scores of the readmitted patients and those who were not. We calculated the area under the curve value for the SWIFT score as 0.548 (95% CI: 0.440–0.656).

CONCLUSIONS: For patients discharged from the PICU, neither the SWIFT score nor APACHE II and mCCI were not sufficient to predict readmission. This study showed that existing scoring systems is insufficient to predict the readmission of patients with respiratory failure, and there is still a need for scoring systems to predict the readmission of these patients.

Keywords:

APACHE II score, intensive care, readmission, SWIFT score

Department of Pulmonology, University of Health Sciences, Atatürk Chest Diseases and Thoracic Surgery Training and Research Hospital, Ankara, Türkiye, [1]Department of Pulmonology, Alanya Alaaddin Keykubat University Faculty of Medicine, Antalya Türkiye

Address for correspondence:
Dr. Deniz Çelik, Department of Pulmonology, Alanya Alaaddin Keykubat University Faculty of Medicine, Antalya Türkiye.
E-mail: drdenizcelik@hotmail.com

Received: 25-04-2022
Revised: 06-06-2022
Accepted: 21-11-2022
Published: 08-02-2023

How to cite this article: Ertan Ö, Çelik D, Yıldız M, Kurt HG. Prediction of pulmonary intensive care unit readmissions with Stability and Workload Index for Transfer score. Eurasian J Pulmonol 2023;25:98-106.

Introduction

It is common and undesirable for patients discharged from the intensive care unit (ICU) to be readmitted to the ICU. The rate of patients discharged from the ICU and readmitted to the ICU in the first 7 days after discharge varies between 5% and 10%.[1,2] The readmission of hospitalized patients to the ICU is associated with higher mortality and prolonged hospital stay.[1,3,4] However, early discharge from the ICU may expose patients to inadequate monitoring and limit timely interventions.[5–7] It is possible to reduce the readmission rate if risk factors for readmission to intensive care are identified and addressed. A scoring system that can accurately estimate the probability of readmission to plan the staged care and use the resources for the patients with the highest risk of deterioration will be useful[5] and will enable the intensive care team to plan both the discharge decision and the treatment after discharge.[8]

As the severity of the disease increases, the 'readmission risk to ICUs increases.[1,9] Additionally, patients with impaired consciousness, males, and elderly patients have more probability of prolonged stay in the ICU and a higher in-hospital mortality rate.[2,8,10,11] Although respiratory failure is prominent in the studies conducted, many reasons, such as gastrointestinal bleeding, arrhythmias, cognitive dysfunction, cardiac ischemia, and pulmonary thromboembolism, may cause readmission to ICU.[12–14] Developing an accurate prediction model for ICU re-hospitalization is challenging due to the complex medical conditions of patients hospitalized in the ICU. To predict readmission and mortality within the first 7 days after discharge from the ICU, a readmission estimation score was developed by Gajic et al.[10] in 2008. However, it can be concluded from the existing literature that this scoring system is generally used for tertiary intensive care patients, and readmitted patients are frequently hospitalized in the ICU for respiratory failure.[15–17] We predict that this scoring system may effectively estimate the readmission and mortality rate for patients who are followed up in the secondary-level ICU due to respiratory pathologies. Therefore, in our study, we evaluated the effectiveness of the Stability and Workload Index for Transfer (SWIFT) score in predicting readmission and mortality to intensive care in our hospital by using it for patients discharged from a secondary-level pulmonary intensive care unit (PICU).

Materials and Methods

Patients discharged from the PICU to the clinic or home between January 1, 2020, and December 31, 2020, were included in the study. Patients referred to a tertiary ICU or another hospital's ICU and patients who died before being discharged were excluded from the study. Patients whose files could not be accessed were excluded from the study.

The Acute Physiology and Chronic Health Evaluation II (APACHE II) score, recorded regularly on admission to the ICU, was obtained from the hospital system. The SWIFT score was calculated retrospectively by evaluating the vital parameters recorded at the time of discharge of the patients, together with the results in the hospital system. The parameters in the SWIFT scores are presented in Table 1.

The PICU has a 23-bed and patients are followed up by three pulmonary medicine specialists and two residents. It is an adult ICU, and patients under 18 are not hospitalized. Discharges occur during the daytime and during working hours. PICU serves patients who need nasal oxygen, noninvasive mechanical ventilation (NIV), or high-flow oxygen therapy due to respiratory pathologies. The decision to discharge the patients from the PICU is based on the opinion of the pulmonary medicine specialist and the pulmonary medicine specialist of the clinic to which they will be discharged.

Demographic data of the patients, diagnoses of ICU admissions, comorbid diseases, modified Charlson Comorbidity Index (mCCI), ICU and hospital admission periods, FiO_2 rates applied during the hospitalization period, APACHE II scores at the first admission to the ICU and SWIFT score during discharge, intensive care admissions (emergency service, clinic, external intensive care), and readmission to PICU were recorded. Readmission after discharge was evaluated in two different ways: the first 7 days and 7–30 days. For patients hospitalized more than once, we evaluated only the first admissions. Treatment results (death/discharge) after readmission were also recorded.

Statistical analysis

Data analyses were conducted using SPSS for Windows, version 22.0 (SPSS, Inc., Chicago, IL, USA). Whether the distribution of continuous variables was normal or not was determined by the Kolmogorov–Smirnov test. Levene's test was used to evaluate the homogeneity

Table 1: SWIFT score[6]

Parameters	Scores
Total ICU length of stay (day)	
<2 days	0
2–10 days	1
>10 days	14
The source of ICU admission	
Emergency department	0
Transfer from a ward, ICU, or outside the hospital	8
Last measured PaO_2/FiO_2 ratio (during the time in ICU)	
>400	0
150–400	5
100–150	10
<100	13
Last arterial blood gas $PaCO_2$	
<45	0
>45	5
Time of Discharge: Glasgow Coma Score	
>14	0
11–14	6
8–11	14
<8	24

Data obtained from the study of Gajic et al.[10] SWIFT: Stability and workload index for transfer, ICU: Intensive care unit, PaO_2: Arterial partial oxygen pressure, FiO_2: Fractional oxygen amount, $PaCO_2$: Arterial partial carbon dioxide pressure

of the variances. Unless otherwise specified, continuous data were described as mean±SD and median (interquartile range), and categorical data were described as a number of cases (%). Statistical analysis differences in not normally distributed variables between two independent groups were compared by the Mann–Whitney U test, and categorical variables were compared using Pearson's Chi-squared test or Fisher's exact test. First, one variable multiple logistic regression was used with risk factors that are thought to be related to mortality and readmission. Risk factors that have a p-value <0.25 one variable logistic regression was included to model multivariable logistic regression. Whether every independent variable was significant in the model was analyzed with Wald statistics. To what extent did the independent variable explain the dependent variable was evaluated with Nagelkerke's R2. Besides, the model adaptation of the estimates was evaluated with the Hosmer–Lemosow model fitting test. Receiver operating characteristic (ROC) curve analysis was used to determine the cutoff points. A value of $p<0.05$ was significant in all statistical analyses.

This study was conducted by the educational board decision of tertiary Ankara Atatürk Chest Disease and Chest Surgery Training and Research Hospital, dated March 11, 2021, and numbered 717. The study was conducted with the approval of the Keçiören Training and Research Hospital Ethics Committee (Date: November 9, 2021, Decision No.: 2012-KAEK-15/2408). All procedures were performed adhering to the ethical rules and principles of the Helsinki Declaration.

Results

A total of 442 patients were hospitalized in our PICU on the specified dates. Of these, 16 cases were excluded from the study because they died before discharge, and 5 were excluded because their data could not be accessed. Of the total patients, 421 patients were included in the study. The mean age was 68.92±12.28, and the male gender was 62.5% (n=263). The mean SWIFT score was 19.52±8.60, and the mean APACHE II score was 16.09±4.26. Of the patients included in the study, 34.9% had atherosclerotic heart disease, 30.6% had congestive heart failure, 36.1% had diabetes mellitus, 17.3% had chronic renal failure, 61.8% had hypertension, and 10.2% had COVID-19 infection. The mean mCCI was calculated as 5.05±2.92. The patients who were readmitted and not readmitted were compared based on demographic features. It was determined that male patients and those with a longer stay in ICU (more than 10 days) had a higher risk factor for readmission. Interestingly, hypertension was significantly lower for readmitted patients (Table 2).

Table 2: Association of readmission with demographic features, comorbidities, APACHE II, SWIFT score, and mCCI

	Non-readmitted (n=388)		Readmitted (n=33)		p
	n	%	n	%	
Gender					
Male	231	59.5	32	97	**<0.001**
Female	157	40.5	1	3	
Age, mean±SD (year),	69.10±12.39		66.79±10.91		0.249
median (IQR)	70 (17)		67 (12.5)		
Atherosclerotic heart failure	137	35.3	10	30.3	0.562
Heart Failure	120	30.9	9	27.3	0.662
Chronic obstructive pulmonary disease	358	92.3	31	93.9	0.999
Diabetes mellitus	144	37.1	8	24.2	0.139
Chronic kidney failure	70	18	3	9.1	0.192
Malignancy	31	8	4	12.1	0.340
Metastatic solid tumor	9	2.3	3	9.1	0.059
Hypertension	246	63.4	14	42.4	**0.017**
COVID-19	42	10.9	1	3	0.231
SWIFT score (mean±SD),	19.39±8.56		21.12±9.07		0.340
median (IQR)	19 (16)		24 (19.5)		
mCCI (mean±SD),	5.06±2.88		4.82±3.46		0.247
median (IQR)	5 (4)		4 (3)		
APACHE II (mean±SD),	16.06±4.35		16.42±2.97		0.291
median (IQR)	16 (6)		17 (4.5)		
For SWIFT score					
Total ICU: length of stay					
2 days	0		2	6.1	**0.003**
2–10 days	215	55.6	14	42.4	
>10 days	172	44.4	17	51.5	
Source of ICU admission					
Emergency department or anesthesia ICU	192	49.6	19	57.6	0.372
Transfer from a ward or outside the hospital	195	50.4	14	42.4	
PaO_2/FiO_2					
>400	10	2.6	1	3.0	0.246
150–400	342	88.4	27	81.8	
100–150	32	8.3	4	12.1	
<100	3	0.8	1	3.0	
$PaCO_2$					
<45	119	30.7	6	18.2	0.132
>45	268	69.3	27	81.8	

Significant p-values are in bold. APACHE II: Acute Physiology and Chronic Health Evaluation II, SWIFT: Stability and Workload Index for Transfer, mCCI: Modified Charlson Comorbidity Index, SD: Standard deviation, IQR: Interquartile range (25%–75%), ICU: Intensive care unit, PaO_2: Arterial partial oxygen pressure, FiO_2: Fractional oxygen amount, $PaCO_2$: Arterial partial carbon dioxide pressure, COVID-19: Coronavirus disease 2019

Mortality was significantly affected by age, chronic obstructive pulmonary disease (COPD), APACHE II score, mCCI score, the source of ICU admission (ward or outside the hospital), and readmission to ICU. We discovered that the SWIFT score did not correlate with mortality. There were significantly more survivors among patients with coronavirus disease 2019 (COVID-19) (Table 3).

We conducted univariate regression analysis using the variables found to be statistically significant with readmission in the analysis shown in Table 2 and the variables associated with the study hypothesis. Gender and the absence of hypertension in patients were associated with readmission in univariate analysis. Only the male gender was considered an independent risk factor for

Table 3: Association of mortality with demographic features, comorbidities, APACHE II, SWIFT score, and mCCI

	Mortality				p
	No (n=304)		Yes (n=117)		
	n	%	n	%	
Gender					
Male	187	61.5	76	65	0.513
Female	117	38.5	41	35	
Age, year (mean±SD),	67.5±12.6		72.59±10.61		**<0.001**
median (IQR)	68 (17)		74 (16)		
Atherosclerotic heart failure	105	34.5	42	35.9	0.793
Heart Failure	91	29.9	38	32.5	0.612
Chronic obstructive pulmonary disease	275	90.5	114	97.4	**0.016**
Diabetes mellitus	114	37.5	38	32.5	0.337
Chronic kidney failure	47	15.5	26	22.2	0.101
Malignancy	23	7.6	12	10.3	0.370
Metastatic solid tumor	6	2	6	5.1	0.081
Hypertension	192	63.2	68	58.1	0.341
COVID-19	37	12.2	6	5.1	**0.017**
Readmission	19	6.3	14	11.9	**0.049**
SWIFT score (mean±SD),	19.13±8.54		20.53±8.7		0.140
median (IQR)	19 (16)		19 (13)		
APACHE II (mean±SD),	15.74±4.1		16.99±4.53		**0.005**
median (IQR)	15.5 (5)		5 (3.8)		
mCCI (mean±SD),	4.77±2.75		5.78±3.22		**0.004**
median (IQR)	4 (3)		5 (3.8)		
For SWIFT score					
Total ICU length of stay					
2 days	1	0.3	1	0.9	0.481
2–10 days	169	55.6	61	52.1	
>10 days	134	44.1	55	47.0	
Source of ICU admission					
Emergency department	162	53.3	49	41.9	**0.036**
Transfer from a ward or outside the hospital	142	46.7	68	58.1	
PaO_2/FiO_2					
>400	8	2.6	3	2.6	0.225
150–400	268	88.2	102	87.2	
100–150	27	8.9	9	7.7	
<100	1	0.3	3	2.6	
$PaCO_2$					
<45	93	30.6	32	27.4	0.514
>45	211	69.4	85	72.6	

APACHE II: Acute Physiology and Chronic Health Evaluation II, SWIFT: Stability and Workload Index for Transfer, mCCI: Modified Charlson Comorbidity Index, SD: Standard deviation, IQR: Interquartile range (25%–75%), ICU: Intensive care unit, PaO_2: Arterial partial oxygen pressure, FiO_2: Fractional oxygen amount, $PaCO_2$: Arterial partial carbon dioxide pressure, COVID-19: Coronavirus disease 2019

ICU readmission in the multivariate analysis performed with this result (Table 4). Men had 19.2 times the number of ICU readmissions as women.

We conducted univariate regression analysis using the variables found to be statistically significant with mortality in the analysis shown in Table 3 and the variables with the study hypothesis. Age, mCCI, APACHE II score, source of ICU admission, Chronic obstructive pulmonary disease, ICU readmission, and COVID-19 were all associated with mortality in univariate analysis. The SWIFT score was unable to predict mortality. Those who had COVID-19 had a lower mortality rate. In multivariate analysis, age and readmission history

Table 4: Univariate and multivariate logistic regression analyses for readmission

	Univariate logistic regression			Multivariate logistic regression		
	OR	95% CI	p	OR	95% CI for OR	p
Age	0.985	0.958–1.013	0.300	–		
Gender (male)	21.749	2.941–160.809	0.003	19.268	2.585–143.588	**0.004**
SWIFT score	1.024	0.982–1.067	0.267	–		
mCCI score	0.971	0.856–1.101	0.642	–		
APACHE II score	1.020	0.940–1.107	0.634	–		
Hypertension	0.425	0.207–0.874	0.020	1.669	0.799–3.489	0.173
Total ICU length of stay	1.334	0.665–2.718	0.427	–		

Statistically significant p-values are in bold. Hosmer–Lemeshow p>0.05. OR: Odds ratio, CI: Confidence interval, SWIFT: Stability and Workload Index for Transfer, mCCI: Modified Charlson Comorbidity Index, APACHE II: Acute Physiology and Chronic Health Evaluation II, ICU: Intensive care unit

Table 5: Univariate and multivariate logistic regression analyses for the prediction of mortality

	Univariate logistic regression			Multivariate logistic regression		
	OR	95% CI	p	OR	95% CI	p
Age	1.037	1.018–1.057	<0.001	1.024	1.002–1.047	0.035
SWIFT score	1.019	0.994–1.045	0.136	–		
mCCI	1.122	1.043–1.206	0.002	1.050	0.966–1.141	0.249
APACHE II	1.070	1.018–1.125	0.007	1.039	0.982–1.099	0.183
Transfer from a ward or outside the hospital	1.555	1.020–2.372	0.040	1.547	0.960–2.494	0.073
COPD	4.417	1.320–14.780	0.016	2.526	0.684–9.337	0.165
Readmission	2.039	0.986–4.215	0.055	2.267	1.061–4.843	0.035
COVID-19	0.389	0.159–947	0.038	0.519	0.198–1.360	0.182

Statistically significant p-values are in bold. Hosmer–Lemeshow p>0.05. OR: Odds ratio, CI: Confidence interval, SWIFT: Stability and Workload Index for Transfer, mCCI: Modified Charlson Comorbidity Index; APACHE II: Acute Physiology and Chronic Health Evaluation II, COPD: Chronic obstructive pulmonary disease, COVID-19: Coronavirus disease 2019

are independent risk factors for mortality (Table 5). One unit increase in age was associated with a 1.024-fold increase in mortality risk (p=0.001), while readmission mortality increased 2.267-fold (p=0.035).

We examined the diagnostic performance of age, mCCI, APACHE II, and SWIFT score by performing ROC curve analysis [Figs 1, 2]. According to ROC curve analysis, age, SWIFT scores, mCCI, and APACHE II scores cannot predict readmission after discharge (p>0.05). When the specified parameters were evaluated in terms of mortality, the SWIFT score was insufficient for predicting mortality (p=0.136), but age, mCCI, and APACHE II scores were sufficient. The parameter with the highest performance in predicting mortality was age (AUC: 0.621); the optimal cutoff value was 70.5 years and its sensitivity was 61.2% (Table 6).

Discussion

For patients hospitalized in the secondary level PICU due to respiratory failure, we found the readmission rate within 7 days after discharge to be 1.9% and 5.9% within 30 days. Although the mean SWIFT score of our readmitted patients was 21.12±9.07, it was not statistically significant. Being male and prolonged ICU stay were observed as risk factors for readmission.

The SWIFT score, created and validated by Gajic et al.[10] in 2008, was calculated over a total of 64 points, including the place of admission to the ICU, the duration of stay in the ICU, the PaO_2/FiO_2 ratio, the Glasgow Coma Score and the $PaCO_2$ value in the last arterial blood gas taken during discharge. It is understood that a score of 15 and above can predict readmission. In their study, Oakes et al.[18] stated

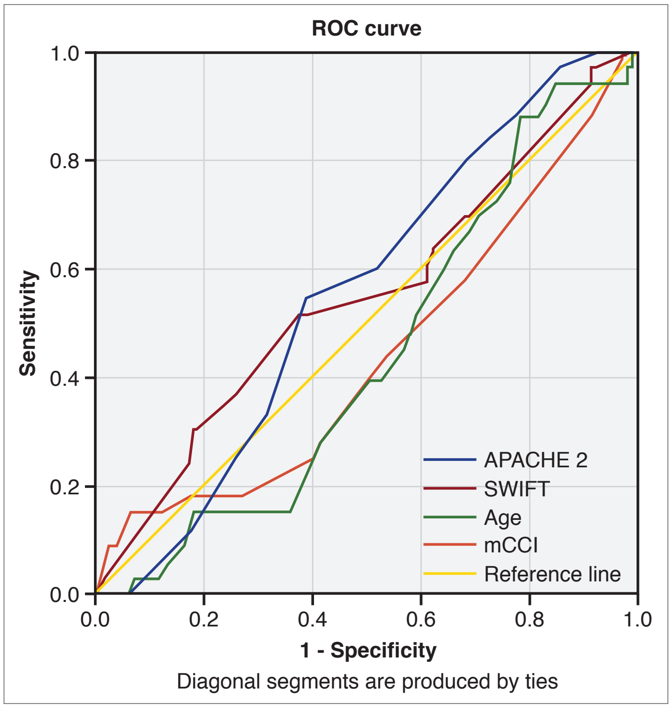

Figure 1: Receiver operating characteristic curve for readmission. SWIFT, mCCI, and APACHE II scores cannot predict readmission after discharge

APACHE II: Acute Physiology and Chronic Health Evaluation II, SWIFT: Stability and Workload Index for Transfer, mCCI: Modified Charlson Comorbidity Index

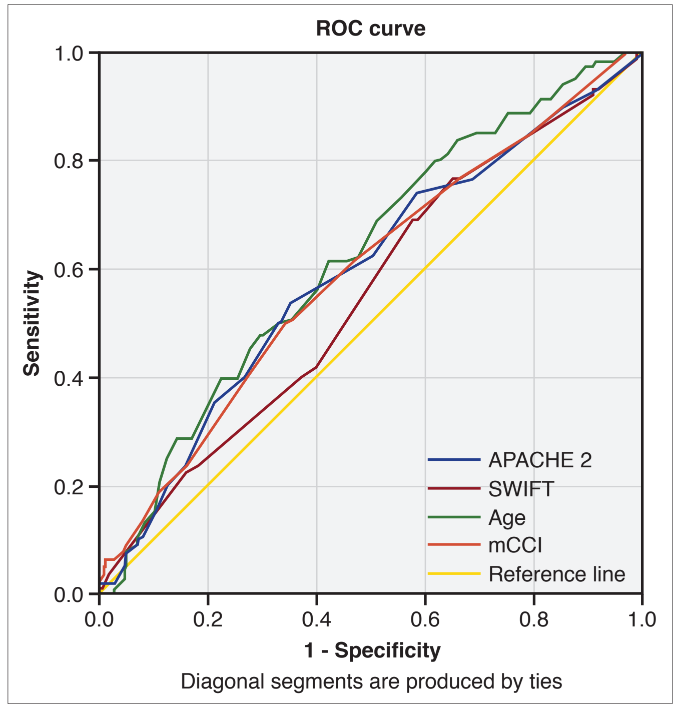

Figure 2: Receiver operating characteristic curve for mortality risk

APACHE II: Acute Physiology and Chronic Health Evaluation II, SWIFT: Stability and Workload Index for Transfer, mCCI: Modified Charlson Comorbidity Index

that the SWIFT score could be used to determine readmission. A study conducted with 7175 patients and published in 2013 concluded that the SWIFT score was insufficient to predict readmission.[19] Another study conducted on a tertiary ICU in our country did not find that the SWIFT score significantly predicts readmission.[16] The mean of the SWIFT score was found to be higher for our patients who were readmitted than for those who were not (AUC 0.548), but it was not found to be sufficient in determining readmission to the ICU. This result may be due to the differences in the ICU in which the study was conducted. Still, no study conducted in the secondary-level PICU can be taken as a reference in the literature. In a study by Jo et al.,[20] 33 of 343 patients included in the study were readmitted to the ICU, and reason for hospitalization of 87.9% of patients had respiratory failure. Although they did not evaluate the SWIFT score in the study, they added the PaO_2/FiO_2 ratio and found no statistically significant difference.[20] Similarly, in our study, most patients who were followed up in our PICU were patients who needed NIV due to chronic hypercapnic respiratory failure. Half of the patients were

Table 6: Receiver operating characteristic curve analysis of age, SWIFT score, APACHE II score, and mCCI for readmission and mortality

Test result variable(s)	AUC	p	95% CI	Cutoff	Sensitivity	Specificity
For readmission						
Age	0.440	0.255	0.352–0.528	–	–	–
SWIFT score	0.548	0.357	0.440–0.656	–	–	–
mCCI	0.440	0.250	0.334–0.546	–	–	–
APACHE II	0.554	0.299	0.468–0.641	–	–	–
For mortality						
Age	0.621	**0.001**	0.563–0.680	70.5	61.2	57.6
SWIFT score	0.550	0.112	0.489–0.611	–		
mCCI	0.591	**0.004**	0.530–0.652	5.5	49.1	66.1
APACHE II	0.590	**0.004**	0.529–0.652	16.5	53.4	64.8

Statistically significant p-values are in bold. SWIFT: Stability and Workload Index for Transfer, APACHE II: Acute Physiology and Chronic Health Evaluation II, mCCI: Modified Charlson Comorbidity Index, AUC: Area under curve, CI: Confidence interval transferred from tertiary intensive care and underwent invasive mechanical ventilation. Although this caused a prolongation in the duration of hospitalization, it explains why the mean SWIFT score of this study was higher than the cutoff score of 15 specified in the study by Gajic et al.[10]

Readmission to an ICU has increased the mortality risk, similar to the study by Gajic et al.[10] Still, they found the SWIFT score value insufficient in predicting mortality. As in similar studies in the literature, it has been observed that older age, APACHE II score, and increasing disease severity affect mortality.[2] In the study conducted in Poland in which 21 495 patients were included, readmission was calculated for the first 30 days and was determined to be 3.9%, and 17.2% of patients who were readmitted had a chronic respiratory failure.[21] In the study by Wong et al.,[1] the presence of COPD was shown as an independent risk factor for ICU readmission. In our study, we determined the rate of readmission to the ICU in the first 30 days as 7.8%. Most of the patients had advanced-stage COPD. These patients had frequent emergency room admissions, were repeatedly hospitalized in the ward/ICU, received long-term oxygen and domiciliary NIV treatment, and were noncompliant with the treatment. The rate of readmission has remained below the expected. The reason for this is the COVID-19 pandemic. Due to the pandemic we have been experiencing since December 2019, our patients choose to stay at home until their complaints are unbearable and their treatments remain incomplete. Another scenario may be that COVID-19 infection is naturally prioritized in hospital admissions due to respiratory symptoms. During this period, 49 patients had COVID-19 pneumonia and were followed up due to ongoing hypoxic respiratory failure in our ICU after the isolation period. Six (12.2%) of them died before being discharged. Forty-three patients were discharged alive, and 6 (13.9%) had post-discharge mortality. For the stated reasons, the triage of respiratory failure patients is crucial in terms of the success of the treatment.

APACHE II scores calculated during hospitalization and indicating disease severity are routinely used to predict mortality risk in our PICU. In a meta-analysis, it was stated that the APACHE II scoring calculated regardless of the time (during admission to the ICU or discharge) is useful in predicting the risk of readmission.[1] APACHE II scoring was not considered sufficient in predicting readmission after discharging our patients, but it predicted mortality as literature. As a result of our research, it was revealed that age and readmission were independent variables in predicting mortality. In contrast, the male gender was the only independent variable predicting ICU readmission.

In conclusion, we could not identify any scoring method that could predict ICU readmission. This result leads us to the conclusion that new readmission scoring systems are required for the PICU cohort. Until then, the severity of the disease and the likelihood of mortality are determined by existing scoring systems such as APACHE II, mCCI, and age.

Limitations

The most important limitation of our study is that it is a single-center study. Although our PICU is a secondary ICU, most pulmonary disease patients are admitted or referred as our hospital is a chest disease hospital. This situation can be considered a potential source of bias. Using precisely 1 year data helped to avoid bias that could arise due to the seasonal nature of COPD exacerbations. The fact that we did not find any other study on the respiratory ICU in the literature review proves the strength of our study. Still, it is also a limitation in comparison.

Conclusion

This study showed the SWIFT score is insufficient in the second-level PICU for predicting readmission and mortality as a consequence of our research. We knew that studies on SWIFT scoring in the literature were carried out in tertiary ICUs. The analysis of readmission and mortality in PICU using the SWIFT score, APACHE II, mCCI, and other indicators may be one of the earliest studies to do so. This study shows that current scoring systems are insufficient to predict patients with respiratory failure being readmitted. There is a need for simple-to-use scoring systems that can predict readmission.

Conflicts of interest

There are no conflicts of interest.

Ethics Committee Approval

The study was approved by the Keçiören Training and Research Hospital Clinical Research Ethics Committee (No: 2012-KAEK-15/2408, Date: 09/11/2021).

Financial support and sponsorship

Nil.

Peer-review

Externally peer-reviewed.

Authorship Contributions

Concept – Ö.E., D.Ç., M.Y., H.G.K.; Design – Ö.E., D.Ç., M.Y., H.G.K.; Supervision – Ö.E., D.Ç., M.Y., H.G.K.; Funding – Ö.E., D.Ç., M.Y., H.G.K.; Materials – Ö.E., D.Ç., M.Y., H.G.K.; Data collection &/or processing – Ö.E., D.Ç., M.Y., H.G.K.; Analysis and/or interpretation – Ö.E., D.Ç., M.Y., H.G.K.; Literature search – Ö.E., D.Ç., M.Y., H.G.K.; Writing – Ö.E., D.Ç., M.Y., H.G.K.; Critical review – Ö.E., D.Ç., M.Y., H.G.K.

References

1. Wong EG, Parker AM, Leung DG, Brigham EP, Arbaje AI. Association of severity of illness and intensive care unit readmission: A systematic review. Heart Lung 2016;45:3–9. [CrossRef]
2. Rosenberg AL, Watts C. Patients readmitted to ICUs*: A systematic review of risk factors and outcomes. Chest 2 000;118:492–502. [CrossRef]
3. Lee H, Lim CW, Hong HP, Ju JW, Jeon YT, Hwang JW, et al. Efficacy of the APACHE II score at ICU discharge in predicting post-ICU mortality and ICU readmission in critically ill surgical patients. Anaesth Intensive Care 2015;43:175–86. [CrossRef]
4. Metnitz PG, Fieux F, Jordan B, Lang T, Moreno R, Le Gall JR. Critically ill patients readmitted to intensive care units--lessons to learn? Intensive Care Med 2003;29:241–8. [CrossRef]
5. Desautels T, Das R, Calvert J, Trivedi M, Summers C, Wales DJ, et al. Prediction of early unplanned intensive care unit readmission in a UK tertiary care hospital: A cross-sectional machine learning approach. BMJ Open 2017;7:e017199. [CrossRef]
6. Daly K, Beale R, Chang RW. Reduction in mortality after inappropriate early discharge from intensive care unit: logistic regression triage model. BMJ 2001;322:1274–6. [CrossRef]
7. Renton J, Pilcher DV, Santamaria JD, Stow P, Bailey M, Hart G, et al. Factors associated with increased risk of readmission to intensive care in Australia. Intensive Care Med 2011;37:1800–8. [CrossRef]
8. Ponzoni CR, Corrêa TD, Filho RR, Serpa Neto A, Assunção MSC, Pardini A, et al. Readmission to the intensive care unit: Incidence, risk factors, resource use, and outcomes. a retrospective cohort study. Ann Am Thorac Soc 2017;14:1312–1319. [CrossRef]
9. Rosa RG, Roehrig C, Oliveira RP, Maccari JG, Antônio AC, Castro Pde S, et al. Comparison of unplanned intensive care unit readmission scores: A prospective cohort study. PLoS One 2015;10:e0143127. Erratum in: PLoS One 2016;11:e0148834. [CrossRef]
10. Gajic O, Malinchoc M, Comfere TB, Harris MR, Achouiti A, Yilmaz M, et al. The Stability and Workload Index for Transfer score predicts unplanned intensive care unit patient readmission: initial development and validation. Crit Care Med 2008;36:676–82. [CrossRef]
11. Kramer AA, Higgins TL, Zimmerman JE. Intensive care unit readmissions in U.S. hospitals: patient characteristics, risk factors, and outcomes. Crit Care Med 2012;40:3–10. [CrossRef]
12. Kollef MH, Canfield DA, Zuckerman GR. Triage considerations for patients with acute gastrointestinal hemorrhage admitted to a medical intensive care unit. Crit Care Med 1995;23:1048–54. [CrossRef]
13. Zimmerman JE, Wagner DP, Draper EA, Knaus WA. Improving intensive care unit discharge decisions: supplementing physician judgment with predictions of next day risk for life support. Crit Care Med 1994;22:1373–84. [CrossRef]
14. Doğu C, Doğan G, Kayir S, Yağan Ö. Importance of the National Early Warning Score (NEWS) at the time of discharge from the intensive care unit. Turk J Med Sci 2020;50:1203–9. [CrossRef]
15. Brown SE, Ratcliffe SJ, Kahn JM, Halpern SD. The epidemiology of intensive care unit readmissions in the United States. Am J Respir Crit Care Med 2012;185:955–64. [CrossRef]
16. Ceylan İ, Baltalı S, Kara AG, Erden V. Evaluation of readmission to intensive care unit prediction score in a training hospital. Turk J Intensive Care 2020;18:28–34.
17. Kareliusson F, De Geer L, Tibblin AO. Risk prediction of ICU readmission in a mixed surgical and medical population. J Intensive Care 2015;3:30. [CrossRef]
18. Oakes DF, Borges IN, Forgiarini Junior LA, Rieder Mde M. Assessment of ICU readmission risk with the stability and workload index for transfer score. J Bras Pneumol 2014;40:73–6. [CrossRef]
19. Kastrup M, Powollik R, Balzer F, Röber S, Ahlborn R, von Dossow-Hanfstingl V, et al. Predictive ability of the stability and workload index for transfer score to predict unplanned readmissions after ICU discharge. Crit Care Med 2013;41:1608–15. [CrossRef]
20. Jo YS, Lee YJ, Park JS, Yoon HI, Lee JH, Lee CT, et al. Readmission to medical intensive care units: risk factors and prediction. Yonsei Med J 2015;56:543–9. [CrossRef]
21. Grochla M, Saucha W, Ciesla D, Knapik P. Readmissions to general Icus in a geographic area of poland are seemingly associated with better outcomes. Int J Environ Res Public Health 2020;17:565. [CrossRef]