

Mortality rate in patients admitted to the ICU based on LODS, APACHE IV, TRIOS, SAPS II

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ABSTRACT

The exact classification of diseases and correct prediction of patient outputs could help in optimal uses of ICU beds by reducing unnecessary monitoring. Valid index use to assess ICU patients seems essential to adequately manage the limited services. This study aimed to estimate the mortality rate in patients admitted to ICU based on APACHE IV, LODS, TRIOS, SAPS II scoring systems. This was a cross-sectional study performed on 53 patients admitted to the ICU of Alavi hospital in Ardabil. Data were collected using a checklist including clinical and demographic data of patients. The prediction of mortality was based on scores obtained from each of four indices SAPS, LODS, TRIOS, and APACHE IV tools. Data were analyzed by SPSS v.23 and the p-value <0.05 was considered significant. 56.6% of patients were male and the rest were female. The mean age of the patients was 71.8 years (20-97). Of all patients, 56.6% died during study time. Results of mortality prediction by four indices showed that the APACHE IV with 33.5% and LODS with 27.8% had the highest and lowest rate, respectively. The relation between mortality prediction rate by APACHE IV and TRIOS with uses ventilator and SO₂ amount were significant. According to the roc curve, the mortality prediction rate with APACHE IV with 76% was more than TRIOS with 57%. Results showed that among all four indices, the best and efficient system in the prediction of mortality rate in patients was APACHE IV, which had good calibration in comparison with other indices.

Keywords: Hospital mortality, Intensive care unit, Three days recalibrated ICU outcome score, Acute physiology and chronic health evaluation, Simplified acute physiology score, Logistic organ dysfunction score

Introduction

One of the crucial challenges of the health care system is the improvement of the quality of life, reducing the duration of hospitalization, and the mortality rate of patients [1]. Hospital mortality rate is closely related to medical facilities and equipment of hospital, the number of health care staff, type of hospitals (teaching or non-teaching), quality of nursing and medical care, availability of different wards, specification of

hospitalized patients, and severity and type of diseases. The most important indicator in assessing the therapeutic abilities of hospital wards, especially ICU, is the study of mortality in these wards [2]. Some reports indicated an increase in the number of patients admitted to the ICU in recent years. Due to the critical condition of patients in ICU, the rate of morbidity and mortality of them is mostly high. Various factors such as aging, acute onset of the disease, specific past medical history such as emergency admission to the ICU, immunosuppression, the need for kidney transplantation, and malignancy increase the risk of mortality in ICU [3]. Global estimates show that the mortality rate in the ICU is 6-40%, in a condition that special medical care has been provided [4]. However, this amount has been estimated between 27.9% to 33.7% in Iran [4, 5]. On the other hand, ICU is one of the most expensive wards of the hospital and the longer stay of patients in this ward will come at higher costs [6]. Improving therapeutic facilities and increasing the use of new technologies over the past years have increased the use of the ICU. Estimating

Access this article online

Website: www.japer.in

E-ISSN: 2249-3379

How to cite this article: Yousefian M, Ghazi A, Amani F, Movaffagh B. Mortality rate in patients admitted to the ICU based on LODS, APACHE IV, TRIOS, SAPS II. *J Adv Pharm Educ Res.* 2022;12(1):56-62. <https://doi.org/10.51847/CgHzosuz9x>

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the number of required beds for the ICU depends on the triage and discharge of patients and the indication and duration of hospitalization [7]. Accurate classification of diseases and proper prediction of discharge of patients can help optimize the use of ICU beds by reducing unnecessary monitoring [4, 5]. Over the past years, various tools have been developed to predict the mortality rate of hospitalized patients, as well as to evaluate and classify the severity of diseases, to create better clinical conditions for patients' treatment [8]. Despite the invention of many effective evaluating systems in recent years, several training centers and hospitals in the country still use only the vital signs and GCS system to evaluate the condition of patients [4]. Therefore, the use of a valid index to evaluate the patients admitted to the ICU seems necessary to be able to effectively manage the limited services for patients in need [9]. APACHE IV and TRIOS indices are able to accurately predict the mortality rate and duration of patients' hospitalization in the ICU. The results of these systems are highly dependent on the time of their use [10]. The results of some studies show that some patients admitted to the ICU do not need intensive care, but only need continuous monitoring of vital signs or more nursing care than the general ward [11]. Due to the limited number of ICU beds, admission of only critical patients is ideal to save their lives [11, 12]. Due to the importance of obtaining information about the mortality rate of patients admitted to the ICU and proper management of beds and providing nursing care for patients, the present study aimed to compare the mortality rate of patients admitted to the ICU using APACHE IV, SAPS II, LODS, and TRIOS scoring systems.

Materials and Methods

The present cross-sectional descriptive study was performed on 53 patients admitted to the ICU of Alavi Hospital in Ardabil city. Patients with a history of cardiopulmonary resuscitation, burning, and patients who deceased in less than 24 hours of hospitalization in the ICU were excluded from the study. The data collected by using a checklist containing information about GCS and vital signs of patients, demographic and clinical information such as age, gender, date and duration of hospitalization, organ function, and need for ventilator during the first 24 h of hospitalization in ICU. Patients' mortality was predicted by the scores obtained from each of the four scoring systems; APACHE IV, TRIOS, LOD, SAPS II. The APACHE IV index consists of three components, age adjustment, chronic health evaluation (CHE), and acute physiology score (APS), which is scored between 0 to 71. APS includes 12 parameters: arterial oxygen pressure (if $F_{iO_2} < 50\%$) or alveolar-arterial oxygen pressure gradient (if $F_{iO_2} \geq 50\%$), respiratory rate, mean arterial blood pressure, central body temperature, heart rate, arterial pH or serum bicarbonate if lack of analysis of arterial blood gases, serum level of creatinine, potassium, and sodium, and hematocrit, WBC count, and GCS in patients who underwent elective surgery, which was calculated after waking up and removing the effect of anesthetic drugs. Patients' level of

consciousness was assessed by opening their eyes, speaking, and reacting to motor stimuli, which was scored from 1-15.

Three days recalibrated ICU outcome score (TRIOS) is a criterion for predicting 3-day mortality of patients admitted to the ICU, which includes parameters for transferring patients from ICU, presence of chronic disease, change in SAPS II or LODS, and LODS and SAPS II scores, which are calculated on the second and third days. Chronic diseases such as biopsy-proven cirrhosis, class IV chronic heart failure, severe chronic obstructive pulmonary disease requiring oxygen therapy at home, chronic dialysis, immunosuppression such as AIDS, leukemia, radiotherapy, chemotherapy, High dose and long-term steroid therapy, and pulmonary hypertension in patients who had not recently had surgery or had emergency surgery were given five points and in case of elective surgery, two points were given to the patient. SAPS II is also a criterion for predicting the mortality rate of patients based on age, heart rate, body temperature, urinary output, and blood tests, which at the score of 0-10, mortality was considered 10%, at the score of 11-40, mortality was considered 25%, at the score of 41-52, mortality was considered 50%, at the score of 53 to 64, mortality was considered 75%, and at the score of 65 to 77, mortality was considered 90%. Logistic Organ Dysfunction Score (LODS) is a criterion to predict the mortality of patients based on age, heart rate, systolic pressure, blood tests, and urine output, which is scored from 0 to 19. The collected data were analyzed using T-test and Logistic Linear regression methods in SPSS statistical software version 23 and P-value $< 5\%$ was considered as significant.

Results and Discussion

Of all 53 patients who were eligible to take part in this study, 56.6% were male and 43.4% were female. The mean age of patients was 71.8 years old (20-97). During the study, 56.6% of patients died. Prediction of patients' mortality rate by using APACHE IV, LODS, TRIOS, SAPS II indices showed that the APACHE IV system and the LODS system had the highest and lowest mortality rate prediction with 33.5% and 27.8 %, respectively. Also, the APACHE IV system had the highest mortality rate prediction index in patients under 60 and 60-80 years old, with 42% and 34.6%, respectively, and in patients over 80 years old, SAPS II had the highest mortality rate prediction with 31.6%. The accuracy of prediction of mortality rate using APACHE IV reduced as the age increased (**Table 1**). The results showed that predicting mortality rate of patients using APACHE IV and TRIOS had a statistically significant relation with connecting patients to a ventilator and SO_2 but had no significant relation with gender and heart rate and in the case of hypertension, only had a relation with the APACHE IV system (**Table 2**). The results of the Pearson correlation coefficient showed that the relationship between age and APACHE IV score and also the relation between age and TRIOS score was negative but nonsignificant. The relationship between the duration of hospitalization and APACHE IV score and also the relation

between duration of hospitalization and TRIOS score was positive but nonsignificant. The relation between the APACHE IV score and TRIOS score was positive but nonsignificant and these two indicators did not have a good overlap in predicting the mortality rate of patients (**Figure 1**). Comparison of the efficacy of SAPS II, APACHE IV, LODS, and TRIOS models in predicting mortality rate of patients based on the ROC CURVE, model showed that the best and most effective system was APACHE IV in terms of the mean score of predicting, which had good calibration and compared to TRIOS, was slightly higher but

not significantly different. Based on the area under the curve of the receiver operator characteristic (ROC), the mortality prediction rate using the APACHE was 76%, which was higher than the TRIOS with 57% (**Figure 2**). The predicted mortality rate using the APACHE IV index was 27.7%, which was higher than other indices. Considering the actual mortality rate of this study (56.6%), the standardized mortality rate equals $56.6/27.7=2.04$, which means that the actual mortality rate is about twice that shown by the APACHE IV system (**Figure 3**).

Table 1. Prediction of patients' mortality rate by using four indices APACHE IV, LODS, TRIOS, and SAPS

INDEX	Age	live		dead		p-value
		n	%	N	%	
APACHE IV	<60	4	23	6	42	0.15
	60-80	11	19	14	34.6	0.002
	>80	8	22.1	10	26.4	0.6
	Total	23	20.2	30	33.5	0.003
TRIOS	<60	4	28.9	6	29.8	0.94
	60-80	11	24	14	31.8	0.3
	>80	8	17.1	10	26.1	0.25
	Total	23	22.4	30	29.8	0.12
SAPS	<60	4	19.1	6	28.4	0.45
	60-80	11	18.1	14	31.3	0.036
	>80	8	15.8	10	31.6	0.026
	Total	23	17.1	30	30.7	0.001
LODS	<60	4	16.1	6	36.4	0.08
	60-80	11	9.1	14	28.1	0.016
	>80	8	12.7	10	21.9	0.2
	Total	23	11.5	30	27.8	0.001

Table 2. Prediction of mortality rate by using APACHE IV and TRIOS by gender and uses a ventilator and clinical symptoms

Parameters		APACHE IV	P-value	TRIOS	p-value
Gender	Male	27	0.6	23.5	0.17
	Female	29		30.2	
Uses ventilator	+	38.3	0.001	31.4	0.025
	-	16.2		20.8	
SO ₂	Normal	37.3	0.001	33.8	0.004
	<90	20		20.4	
HR	Normal	32.6	0.22	22.1	0.3
	At-risk	26.2		28	
HTN	+	34	0.024	27.6	0.7
	-	23.5		25.6	

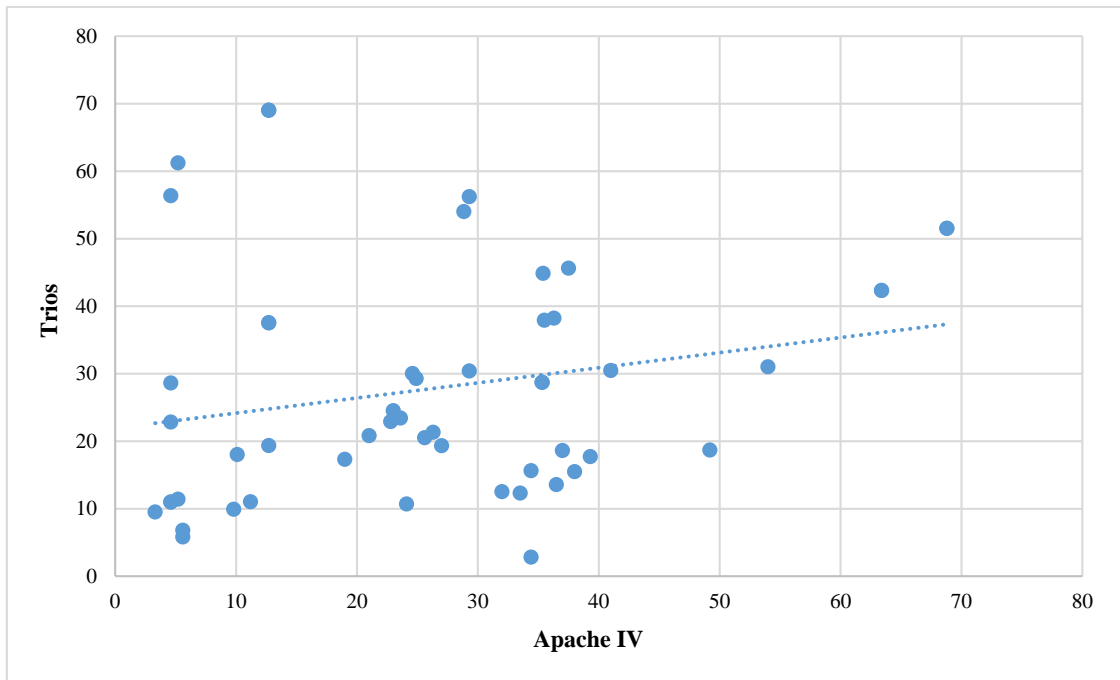


Figure 1. Correlation between APACHE IV and TRIOS

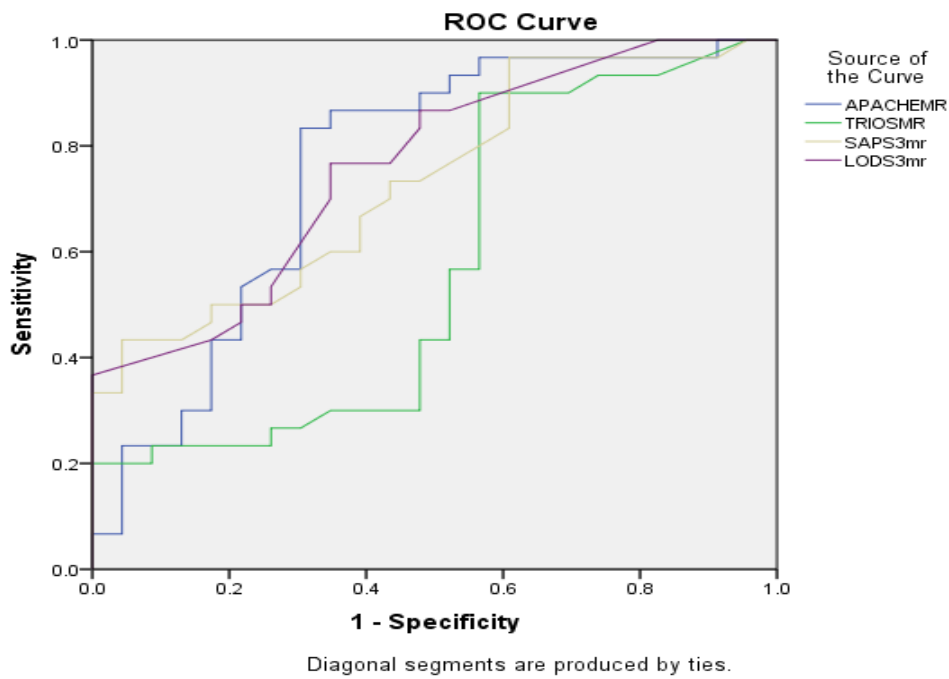


Figure 2. ROC Curve for compare efficacy of four indices

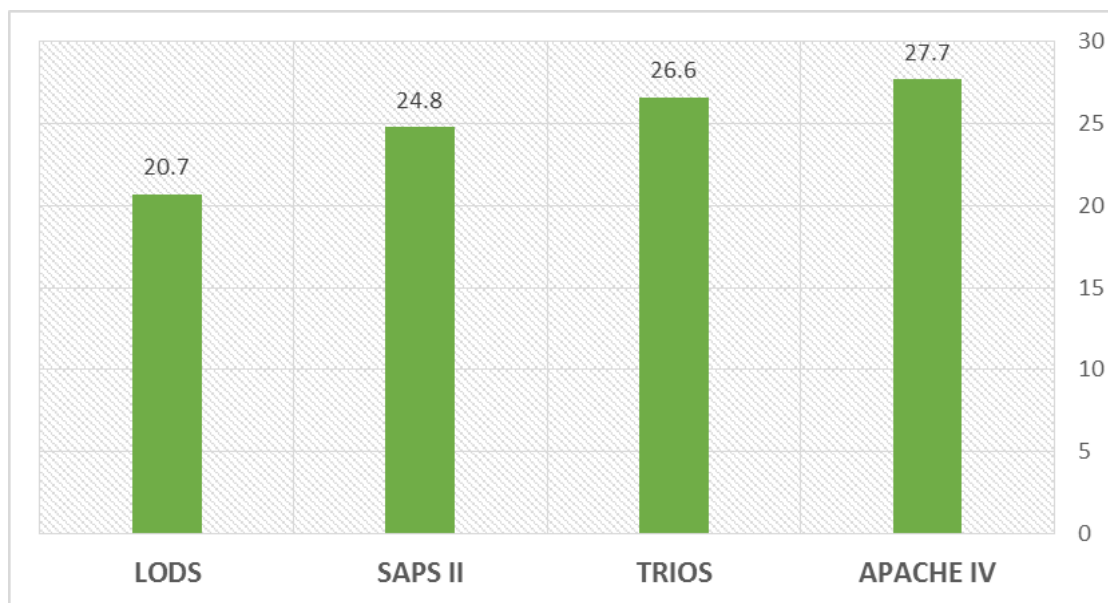


Figure 3. Compare four indices based on mortality rate prediction

In this study, 56.6% of patients were male, the mean age was 71.8 years old and 56.6% died during study time. The mean total score of APACHE IV in all patients was 27.7% and the mean score of APACHE IV in deceased patients was 33.5%, which was significantly higher than living patients with 20.2%. A study by Male *et al.* in 2017 showed that 44.1% of patients were female and the mean age of patients was 60.5 ± 17.7 years old. Of all patients, 11.6% died during hospitalization and the mean score of APACHE IV in these patients was 22.1% [13]. A comparison of the results of the present study with those of the above study showed that the mean score of APACHE IV in the present study was slightly higher. A study by Pattisin *et al.* in 2018 on predicting the mortality rate of patients by the APACHE IV scoring system in patients admitted to the ICU showed that 47% of patients were female and their mean age was 62 years old, and 22% of them died. The APACHE IV score was 32.5% in deceased patients versus 54.3% in living patients. Comparison of the results of the above study with the present study demonstrated that the mortality rate of that study was relatively high, which could be due to the larger sample size [14]. In a study by Abolghasemi *et al.* in 2017, the difference between the mean score of APACHE-IV in deceased and living patients was significant. Moreover, the study of the relationship between the scores obtained from the APACHE-IV scoring system in most of the studied variables showed that this correlation was very significant in groups <50 years, which was similar to the present study [15]. Our results in line with other studies showed APACHE IV as the best scoring system for predicting mortality rate [16, 17]. Zaidi *et al.* studied 36 patients in 2019, in which 22 survived and 14 died after follow-up for 12 days. In linear regression analysis, all scoring systems were significantly related to mortality rates. However, APACHE II was the only accurate predictor of mortality, and predicted the highest mortality rate (19.3%), while the SAPS II and SOFA scoring systems predicted 6.8% and 13.5%, respectively [18]. Regression analysis of the present study also showed that APACHE IV was better than other

scoring systems in predicting mortality rate. Some studies have reported good calibration for LODS in predicting the mortality rate of patients in ICU relative to the APACHE IV system [19-22]. Based on the results of the present study, LODS had almost similar and close predictions to APACHE IV and was not significantly different from it. In a study conducted by Yaghoubi *et al.* in 2014 on 60 patients admitted to the ICU, the results showed that the average APACHE IV score was 30%. Also in the study of Bahrami *et al.* in 2010 on 240 patients admitted to the ICU, the mean score of APACHE IV was 50.62%. [4, 23]. In the study of Moieni *et al.*, the average score of APACHE IV in predicting mortality rate was 23.9% and in the study of Mustafa Kamal *et al.* in 2012, the mortality rate predicted by the APACHE IV system was 90% [24, 25]. Compared to the above studies, the predicted mortality rate based on the APACHE IV system in the present study was lower than that of Yaghoubi's, Bahrami's, and Mustafa Kamal's study, but was higher than the Moieni's study, which may be due to different hospital standards including the availability of medical equipment in the ward, recruitment of sufficient specialized staff, effects of shift work on the quality of provided services, and differences in hospital governance policies.

Conclusion

The results of the present study showed that all scoring systems can be utilized to predict the mortality of patients hospitalized in the ICU, but APACHE IV is more effective and useful than the others. The use of various versions of these systems makes it easy to evaluate patients and also saves on the use of human resources to collect vital information about patients. The results of these scoring systems can be a very reliable and accurate index for clinical decision-making of physicians and nurses. The differences among indicators in most studies and the present study can be due to various factors that affect the accuracy of predicting patients' mortality rate. These factors include the limitation of

systems used in this study, the individual differences of the patients of this study with the patients who were examined for the validation of the systems, etc.

Acknowledgments: The authors acknowledge with grateful appreciation the kind assistance of ICU nurses.

Conflict of interest: None

Financial support: None

Ethics statement: This study was ethically approved by ethical committee of Ardabil university of medical science and registered by code IR.ARUMS.REC.1398.151.

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