

Research Article

Utility of the Therapeutic Intervention Scoring System-28 to Predict Mortality in Intensive Care Units

Yasemin Tekdos Seker, Oya Hergunsel, Ipek Bostanci, Ayten Zeydan

Department of Anesthesia, University of Health Sciences, Bakirkoy Dr. Sadi Konuk Training and Research Hospital, Istanbul, Turkey

Abstract

Objectives: We compared the commonly used Acute Physiology and Chronic Health Evaluation (APACHE) II score and Sequential Organ Failure Assessment (SOFA) score with the quicker and easier Therapeutic Intervention Scoring System (TISS)-28 to examine mortality in intensive care units (ICUs).

Methods: Patients treated in the ICU at Bakirköy Dr. Sadi Konuk Research and Training Hospital between May 2012 and January 2017 were included in the present study. Patients who made a full recovery and were discharged were defined as group 1, whereas those who died were defined as group 2. TISS-28 scores recorded twice in the first 24 h and APACHE II and SOFA scores recorded at the end of 24 h were evaluated. The groups were compared based on demographic data; duration of nursing (h/day); and TISS-28, APACHE II, and SOFA scores.

Results: Of 2191 patients in this 5-year study, 1405 (64%; group 1) were discharged from the ICU and 786 (36%; group 2) died. There was no significant difference in age between the two groups. The median TISS-28 score was 17 in group 1 and 25 in group 2. The median APACHE II score was 18 in group 1 and 29 in group 2. The median SOFA score was 6 in group 1 and 8 in group 2. All three scores were significantly higher in group 2.

Conclusion: TISS-28 scores correlated with APACHE II and SOFA scores, predicting mortality.

Keywords: Disease severity score, predicted mortality, TISS-28

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Because intensive care units (ICUs) are places where critically ill patients are treated aggressively, morbidity and mortality rates are always high. The Acute Physiology and Chronic Health Evaluation (APACHE) II score and Sequential Organ Failure Assessment (SOFA) score are used to measure the severity of illness as well as morbidity and mortality, whereas the Therapeutic Intervention Scoring System (TISS)-28 measures the nursing workload in the ICU. The TISS-28 was developed in 1974 by Cullen et al.^[1] A few years later, Miranda et al.^[2] simplified the system by reducing the number of items from 78 to 28. The 28 items included in the TISS-28 evaluate ventilation; renal, cardiovascular, neurological, and metabolic functions; basic activity; and other factors. The score indicates the amount of nursing time

spent on direct patient care, which in turn points to the severity of illness. The TISS-28 is directly related to nursing time. Few studies have examined the use of the TISS-28 in determining ICU mortality.^[3] Therefore, we compared the TISS-28 score with the commonly used APACHE II and SOFA scores to determine its predictive value.

Methods

The present study was conducted between June 2017 and August 2017 at Bakirköy Dr. Sadi Konuk Research and Training Hospital. After obtaining approval from the hospital's Ethics Committee, patients who had been treated in the ICU between May 2012 and January 2017 were enrolled. Patients who died within 24 h were excluded. Medical re-

Address for correspondence: Yasemin Tekdos Seker, MD. Dr. Sadi Konuk Eğitim ve Araştırma Hastanesi, Sağlık Bilimleri Anabilim Dalı Anestezi Bölümü, İstanbul, Turkey

Phone: +90 212 414 64 33 **E-mail:** dr_ytekdos@hotmail.com

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cords from the electronic file system (MetaVision; iMDsoft, Wakefield, MA, USA) were retrospectively evaluated. Patient demographic information, the duration of nursing (h/day), the TISS-28 score, the APACHE II score, the SOFA score, ICU stages during hospital stay, and the mode of exit from the ICU (death or recovery) were recorded. TISS-28 scores were recorded twice in the first 24 h, whereas APACHE II and SOFA scores were recorded at the end of 24 h. The patients who made a full recovery were included in group 1, whereas those who died were included in group 2. The APACHE II, SOFA, and TISS-28 scores were compared between the two groups.

Statistical Analysis

SPSS version 22.0 (IBM Corp., Armonk, NY, USA) was used to analyze the data. The distribution of the data was evaluated using the Shapiro–Wilk test. Continuous variables were analyzed using the Mann–Whitney test, and categorical variables were compared using the Monte Carlo method. Odds ratios were also calculated. The relationship between the real and estimated specificity and sensitivity values was clarified using receiver operating characteristic curves. Correlations between variables were estimated using Kendall's tau-b test. Continuous variables are presented as medians and ranges in tables (minimum–maximum); categorical variables are presented as n (%). All variables were estimated at the 95% confidence level; $p < 0.05$ was considered significant.

Results

In total, 2667 patients were evaluated. Of these, 476 patients

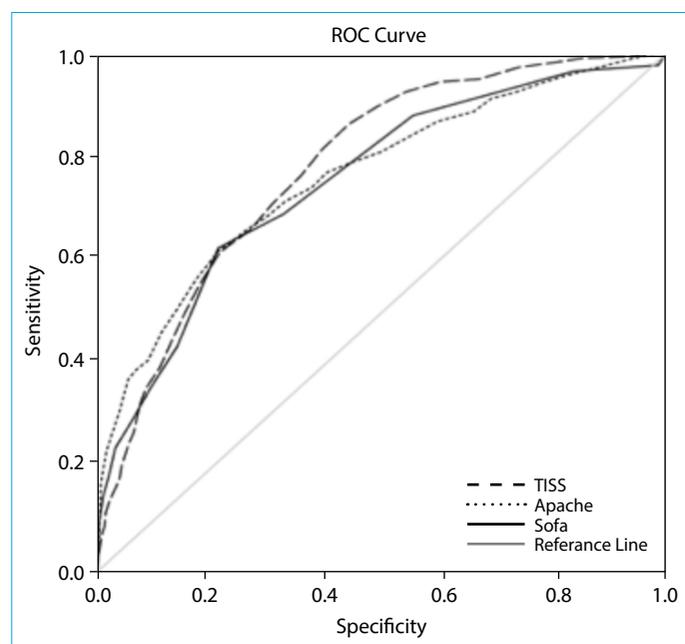


Figure 1. ROC curve of APACHE II, SOFA and TISS-28 scores

who died within 24 h were excluded. Thus, 2191 patients were included in the present study. Of these patients, 1405 (64%) made a full recovery and were included in group 1. The remaining 786 (36%) patients were included in group 2 ($p=0.001$). There was no statistically significant difference in sex between the two groups ($p=0.892$). In terms of age, 609 patients (43%) in group 1 and 484 (62%) in group 2 were older than 59 years. When mortality and age were estimated in the subgroups, we found that the statistically significant cutoff for age was 59 years. The risk of mortality was higher in patients older than 59 years in both groups, as correlated with higher TISS-28, APACHE II, and SOFA scores. The number of patients older than 59 years was higher in group 2. The median duration of nursing was 3 h/day in group 1 and 4.42 h/day in group 2 ($p=0.001$). A duration of nursing greater than 3 h 27 min was significantly correlated with mortality. The median TISS-28 score was 17 in group 1 and 25 in group 2 ($p=0.001$). The median APACHE II score was 18 in group 1 and 29 in group 2 ($p=0.001$). The median SOFA score was 6 in group 1 and 8 in group 2 ($p=0.001$). Demographic data and scores are shown in Table 1. ROC curve of scores is shown in figure 1.

An APACHE II score >29 , a TISS-28 score >28 , and a SOFA score >8 were significantly correlated with mortality. TISS-28 scores were significantly correlated with APACHE II and SOFA scores. Correlation of TISS-28 with APACHE II and SOFA is shown table 2. The duration of care and age comparison between scores is shown in table 3.

Discussion

Many measures, including APACHE II, APACHE 4, SOFA, and Simplified Acute Physiology Score 3 values, are used to predict mortality.^[4–6] In our daily clinical routine, we use

Table 1. Comparison of demographic data and APACHE II, SOFA, and TISS-28 scores for patients with intensive care unit healing (group 1) and deaths (group 2)

	Group 1 (n=1405) Median (min./max.)	Group 2 (n=786) Median (min./max.)	P
Age	55 (2/118)	65 (6/99)	<0.001
Nursing time (h)	3 (0.88/12.37)	4.42 (0.88/11.31)	<0.001
TISS	17 (5/70)	25 (5/64)	<0.001
APACHE II	18 (4/46)	29 (7/45)	<0.001
SOFA	6 (2/20)	8 (3/21)	<0.001
Gender n(%)			
Male	816 (58.08)	454 (57.76)	0.892
Female	589 (41.92)	332 (42.24)	

Mann–Whitney U Test (Monte Carlo); Pearson Chi Square Test (Exact);

*Odds Ratio 95% (Confidence interval); Min.: minimum; Max.: maximum.

APACHE II and SOFA scores to determine mortality, and the TISS-28 score is used by nurses in the ICU. The TISS-28 calculates the amount of nursing time spent on direct patient care and does not require any laboratory findings. This quick and simple test can be administered twice a day and does not require any specialized knowledge. APACHE II, which is used to determine the severity of illness, was developed by Knaus et al.^[7] and is still commonly used. The APACHE II scoring system awards points based on patient age, acute physiological status, chronic health evaluation, and surgical procedures. The points awarded for some of the physiological parameters and threshold values have changed with the APACHE II. For example, changes in consciousness are now at the forefront, and the points for serum creatinine values have doubled.^[8] The factors evaluated using the APACHE II system change more than any other variable in the first 24 h of ICU treatment. Physiological capacity decreases as one ages. Therefore, age is important for detecting the mortality risk dependent on the severity of illness; thus, age increases the score. Elective surgery receives 2 points, whereas emergent surgery or no history of surgery receives 5 points. Immunosuppression or severe organ failure also receives 5 points. The APACHE II, which evaluates acute physiological status, age, and chronic health factors in the first 24 h, has a total of 71 points. Predicted mortality is >80% when the APACHE II score is >35. The SOFA is used to determine secondary organ dysfunction in addition to acute or chronic disease in the ICU. Initially, the score was used to determine organ failure associated with

sepsis, but later it was found that it is also effective for use in nonseptic patients. Unlike the other measures, it determines complications in critically ill patients. Each of 6 organ systems receives points from 1 to 4 (1=normal). Lower scores are recorded during the day.^[7, 9] The TISS-28 has 28 items that evaluate 7 organ systems. Standard monitoring, laboratory monitoring, single medication monitoring, multiple intravenous medications, changing the patient's clothes regularly, severe wound care, and monitoring the drainage tube volume make up 16 points. Cardiopulmonary support, including single or multiple vasoactive drug treatment; invasive cardiovascular monitoring; aggressive fluid replacement (5 L/day); and cardiopulmonary resuscitation within 24 h make up 29 points. Special interventions, including pacemaker cardioversion and endoscopy, make up 13 points. Respiration therapies, including mechanical ventilation and artificial respiration care (e.g., orotracheal tube or tracheostomy), make up 9 points. Renal support hemofiltration and monitoring diuresis make up 8 points. Metabolic support, including acidosis/alkalosis treatment, intravenous hyperalimentation, and enteral nutrition, makes up 9 points. The TISS-28 has a total of 88 points. Each

Table 3. Correlation of TISS-28 score with APACHE II and SOFA scores

Total		r	p
TISS	APACHE II	0.244	<0.001
TISS	SOFA	0.244	<0.001

Kendall's tau-b test ; r: Correlation coefficient.

Table 2. Comparison of age, duration of care, APACHE II, SOFA and TISS-28 scores for patients with intensive care unit healing (group 1) and deaths (group 2)

	Cut off	Group 1 n(%)	Group 2 n(%)	AUC±SE	Odds ratio (95 %CI)	P																																				
Age	<59.5	794 (56.6)**	302 (38.4)	0.614±0.012	2.09 (1.75-2.50)	<0.001																																				
	>59.5	609 (43.4)	484 (61.6)*				Nursing Time (Hour)	<3.27	783 (55.7)**	108 (13.7)	0.779±0.010	7.90 (6.29-9.93)	<0.001	>3.27	622 (44.3)	678 (86.3)*	TISS	<18.5	783 (55.7)**	108 (13.7)	0.779±0.010	7.90 (6.29-9.93)	<0.001	>18.5	622 (44.3)	678 (86.3)*	APACHE II	<26.5	1104 (78.6)**	300 (38.2)	0.760±0.011	5.94 (4.90-7.20)	<0.001	>26.5	301 (21.4)	486 (61.8)*	SOFA	<7.5	1104 (78.6)**	295 (37.5)	0.751±0.011	6.10 (5.04-7.40)
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ROC: Receiver operating characteristic; Analysis: Horley & Mc Neil-youden index J; AUC: Area under the ROC curve; CI: Confidence interval; SE: Standard error
*Sensitivity **Specificity.

point is equal to 10.6 min of nursing time spent on direct patient care.^[2, 10] In the present study, patients who had higher nursing times with higher TISS-28 scores (above 17) had an increased incidence of mortality with high APACHE II and SOFA scores. Thus, we believe that TISS-28 scores can be used to predict mortality correlated with APACHE II and SOFA scores when patients' laboratory results are not yet available.

TISS-28 scores were significantly correlated with APACHE II and SOFA scores, predicting mortality. Many studies have shown the correlation between TISS-28 scores and other scores in surgical and ordinary ICUs.^[11-15] In the present study, the TISS-28 score was approximately 25 in the increased mortality group, which is in line with our literature review. Lefering et al.^[14] found that a TISS-28 score of 28.7 predicted the severity of illness and mortality in a surgical ICU. Padilho et al.^[3] studied 271 patients with a median TISS-28 score of 23 and confirmed a correlation with mortality. Ergan et al.^[15] found that in a study of 166 patients, mortality was higher in patients with a median TISS-28 score of 27. Although the TISS-28 was developed to quantify nursing staff time in the ICU, its similarity with APACHE II and SOFA scores has been noted. Muchler et al.^[16] found that among 6903 surgical ICU patients, the type of surgery affected the TISS-28 score and also the correlation between TISS-28 and SOFA scores. The literature also demonstrates that increased TISS-28 scores in head trauma patients, in obstetrics patients, or after surgery in ICUs are correlated with the severity of illness as measured using the SOFA.^[17-19] In the present study, mortality was higher when the duration of nursing, and thus the TISS-28 score, increased.

There are some limitations of our study. For example, data were collected by retrospective file scanning. Moreover, patients were not chosen according to their initial ICU inclusion criteria. The TISS-28 scores of the patients who underwent surgery were higher, and this may have affected our results.

Conclusion

Higher TISS-28 scores reflect more time in the ICU and more time invested by nursing staff. These scores were found to correlate with scores for predicted mortality used in ICUs. Because the main goal of the ICU team is to reduce mortality, and given the relationship between nursing time and mortality, we believe that using the TISS-28 may be an efficient way to provide more effective nursing care (e.g., by planning the number of nurses needed for each patient) and may reduce mortality.

Disclosures

Ethics Committee Approval: The study was approved by the

Local Ethics Committee of Bakırköy Dr. Sadi Konuk Training and Research Hospital Hospital with 2017/72 number.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship contributions: Concept – Y.T.S.; Design – Y.T.S.; Supervision – O.H.; Materials – A.Z.; Data collection &/or processing – A.Z.; Analysis and/or interpretation – Y.T.S., O.H.; Literature search – Y.T.S.; Writing – Y.T.S., I.B., O.H.; Critical review – O.H.

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