Original Article

Application of APACHE-II and SOFA score as a Predictive Outcome in Ramathibodi Surgical Intensive Care Unit

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Background: Acute Physiology and Chronic Heatlh Evaluation II score (APACHE-II) and Initial Sequential Organ Failure Assessment score (SOFA) score are known as accepted severity scoring. From many studies, they both had good efficacy in predicting mortality for the critically ill patient in the intensive care unit. But in real practice, there are many factors that can affect the accuracy of this scoring system, such as the differences between each intensive care units or the pattern of patients. The aim of this study is to validate the performance of APACHE-II score and Initial SOFA score for predicting ICU mortality of Ramathibodi Surgical Intensive Care Unit.

Materials and Methods: A retrospective reviewed for surgical patients who had been admitted to SICU between 1st May 2011 and 31st December 2011 at Ramathibodi Hospital, All surgical patients were included in this study. Patients, who were younger than 15 years, had ICU admission less than 48 hr for observation after elective surgery was excluded.

Results: One hundred and eighty-five patients were enrolled in this study, twelve (6.5%) deaths were recorded in this SICU, the missing data were found to be 10%, Mean of APACHE-II score was 10.5 whereas mean of initial SOFA was 2.8. The factors that were related to ICU death were non-scheduled admission, sepsis, acute renal failure, APACHE-II score >10 and initial SOFA score >3. In univariate analysis, initial SOFA score had the strong correlation with mortality, especially if initial SOFA >3 (odd ratio = 14). The area under the receiver operating characteristic curve of APACHE-II was 0.85 and initial SOFA was 0.84.

Conclusion: Both SOFA and APACHE-II had good discrimination for predicted ICU mortality for the surgical patients in Ramathibodi surgical intensive care unit. In the present study, we found that SOFA score is comparable to APACHE-II score.

Keywords: APACHE-II, SOFA score, Mortality

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The scoring system was first developed to predict the mortality and outcome in daily practice since 1953 at that time, APGAR score was the first one, being introduced to evaluate the vitality of newborns, and widely used until nowadays. Since then, many scoring modalities were introduced[1].

For Critically ill patients, there were many scoring modalities created to predict the outcome in the early stages, we used mortality rate as the primary outcome. APACHE-II is one of them that was widely validated and used in many ICU's; it showed good prognostication. Even with limitations, such as the factor that was used for evaluation it only come from within the first 24 hr or the ignorance of the many factors that influence the outcome during ICU stay, it was the most widely used as an outcome predictor in clinical practice and research study[1-3].

The Sequential Organ Failure Assessment score or "SOFA score" is another good modality that tells the degree of Organ Dysfunction. It consists of a 6-system parameter (Table 1). Each system has a score of 0 (normal) to 4 (the most abnormal) providing a score of 0 to 24 points. The recent study showed the obvious relationship between SOFA score and mortality[4-7].

Both modalities showed good power of discrimination, in real practice. There are many factors that affect the accuracy of those scoring systems such as the difference in ICU setting or the Pattern of Patients in each center. So the objectives of this study are to validate application of APACHE-II and initial SOFA score (referred to "iSOFA score") for predicting ICU mortality in Ramathibodi Surgical ICU, to compare effectiveness of APACHE-II and iSOFA in predicting ICU mortality and to evaluate risk factors of ICU mortality in Ramathibodi Surgical ICU.

Materials and Methods

Our study is a retrospective review, established within 8-bed surgical ICU, in Ramathibodi Hospital from 1st

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Table 1. The Sequential Organ Failure Assessment (SOFA) Score*

Variables	SOFA Score				
	0	1	2	3	4
Respiratory					
Pao2/Fio2 mmHg	>400	≤400	≤300	≤200**	≤100**
Coagulation					
Platelets x103/uL***	>150	≤150	≤100	≤50	≤20
Liver					
Bilirubin, mg/dL***	<1.2	1.2 to 1.9	2.0 to 5.9	6.0 to 11.9	>12.0
Cardiovascular					
Hypertension	No hypertension	Mean arterial pressure <70 mmHg	Dop ≤5 or dob (any dose)****	Dop >5, epi ≤0.1, or norepi ≤0.1****	Dop >15, epi >0.1, or norepi >0.1****
Central nervous system					
Gladgow Coma Score Scale	15	13 to 14	10 to 12	6 to 9	<6
Renal					
Creatinin, mg/dL or urine output, mL/dl*****	<1.2	1.2 to 1.9	2.0 to 3.4	3.5 to 4.9 or <500	>5.0 or <200

* Norepi indicates norepinephrine. Dob = dobutamine; Dop = dopamine; Epi = epinephrine; Fio_2 = fraction of inspired oxygen.
** Values are with respiratory support.
*** To convert bilirubin from mg/dL to µmol/L, multiply by 17.1.
**** Adrenergic agents administered for at least 1 hour (doses given are in µg/kg per minute)
***** To convert creatinine from mg/dL to µmol/L, multiply by 88.4.

May 2011 to the 31st December 2011, and based on medical records and online laboratory data, using all surgical patients as the inclusion criteria. The exclusion criteria for this study were; younger than 15 years old; trauma and burn patients, those in isolated ICU and elective surgical patients with less than 48 hours admission in ICU.

After approved by the ethic committee of Ramathibodi Hospital, we collected demographic characteristic data including primary servicing team, type of admission, length of hospital stay, laboratory data, clinical data, then calculated APACHE-II and iSOFA scores.

SOFA score was calculated from clinical and laboratory data collected from the worst parameter during the ICU admission until the first 24 hours. For patients who were sedated, the Glasgow Coma score was calculated from their medical records before sedation; if the medical record did not mention the GCS it was assumed to be normal[8]. The liver factors, if not examined during the first 24 hours, the nearest data were substituted to calculate liver factor. If there was no record of related-underlying, the liver factor was assumed to be normal. Acute Physiology and Chronic Health Evaluation II (APACHE-II) was calculated as described in the original literature review for the present study[3].

Data were analyzed using STATA version 11th program. Categorical variables were evaluated using the Chi-square test. For Continuous data, we compared using two-tailed Student's t-test and Wilcoxon's rank Sum test. Power of discrimination was test using area under ROC graph. Univariate logistic regression analysis was used to evaluate factors effecting ICU outcome, resulted as odd ratios with 95% confidence intervals. A p-value <0.05 was considered statistically significant.

All missing data were excluded during data analysis.

Results

From the period of the study, there were 487 patients admitted in Ramathibodi Surgical ICU. 342 patients were excluded, because they were admitted less than 48 hours after elective surgery. 185 patients were included in this study. There were 14% missing data. The demographics of the study population are shown in Table 2. The patients' mean age was 63 years. Forty-six percent of patients were admit unscheduled, which indicated emergency conditions, 22.4% of admissions were due to sepsis. The mean length of ICU stay was 4.7 days. The ICU mortality rate was 6.5%.

After categorizing the population into survival analyses, the authors found the factors that were different and statistically significant between both groups (Table 3). In non-survival groups, there were more unscheduled admissions, sepsis and the presence of acute renal failure at admission than survival groups. The mean of APACHE-II score was 18.3 in the non-survival groups and 9.6 in survival groups. The mean iSOFA score was 7.5 in non-survival groups compared to 2.55 in survival groups.

Figure 1 shows the correlation between iSOFA score and mortality rate; we found that the higher the iSOFA score, the higher the mortality rate. The mortality rate significantly changed between iSOFA score, greater or lesser than 3 (1.8% compared to 8.3%). With iSOFA score equal or more than 8, the mortality rate was 55.6%.

The Power of discrimination of iSOFA and APACHE-II was shown as Figure 2-4 for APACHE-II, the ROC was 0.85 (Figure 2) and for iSOFA, the ROC was 0.84 (Figure 3). After excluded the missing data, the compared ROC between APACHE-II and iSOFA was shown in Figure 4. Therefore, iSOFA showed better than APACHE-II in aspect of discrimination with ROC 0.92, 0.85, respectively.

From the univariate logistic regression analysis of mortality and characteristic in the present study, the factor

Table 2. Demographic data of study population

Characteristic	p-values
No. of patients	185
Sex	
Men	92
Women	92
Age, mean (SD) (Range), year	63 (14) (20 to 95)
Length of ICU stay, days	
Mean	4.7
Median	3.0
Range	1 to 43
No. (%) of deaths	12 (6.5)
Type of admission	
Scheduled, No. (%)	89 (54)
Unscheduled, No. (%)	76 (46)
Sepsis, No. (%)	37 (22.4)
APACHE-II	
Mean (SD)	10.15 (5.5)
Median	9
Range	0 to 31
Initial SOFA, iSOFA	
Mean (SD)	2.8 (3.0)
Median	2
Range	0 to 15
Underlying disease, No. (%)	
Ischemic heart disease	32 (19.5)
Congestive heart failure	8 (4.9)
Acute renal failure	20 (12.2)
Chronic renal failure	35 (21.3)
COPD	13 (7.9)
Old CVA	14 (8.5)
Cirrhosis	12 (7.3)
DM	44 (26.8)
HT	93 (56.7)
Malignancy	67 (40.9)
Immunocompromise host	5 (3.1)
Primary unit service	
General	54 (29.19)
Vascular & transplant	37 (20.00)
Orthopedic	27 (14.59)
Neurology	16 (8.65)
ENT	15 (8.11)
CVT	12 (6.49)
Urology	12 (6.49)
OB-Gyn	11 (5.95)
Plastic	1 (0.54)

Table 3. Characteristic of survivor and non-survivor

Characteristic	Survivor (n = 173)	Non-survivor (n = 12)	*p*-values
Age, mean (SD) (range), year	63 (14.6) (20 to 95)	65 (16.7) (27 to 87)	0.56
Length of ICU stay, days			0.39
Mean	4.5	6.5	
Median	3	3.5	
Range	1 to 43	1 to 20	
Unschedule admission (%)	43	90	0.006
Sepsis (%)	20	50	0.046
Acute renal failure (%)	9.47	50.00	0.003
APACHE-II			0.0001
Mean (SD)	9.60 (5.04)	18.3 (6.95)	
Median	8	18.5	
Range	0 to 28	6 to 31	
Initial SOFA, iSOFA			0.0001
Mean (SD)	2.55 (2.61)	7.5 (4.3)	
Median	2	7	
Range	0 to 13	4 to 15	

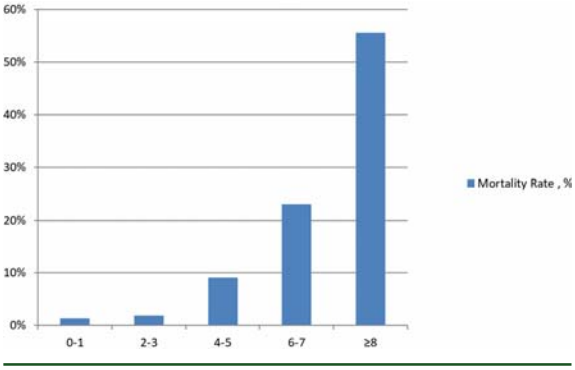

Figure 1. Mortality Rate in Relation to the iSOFA in SICU.

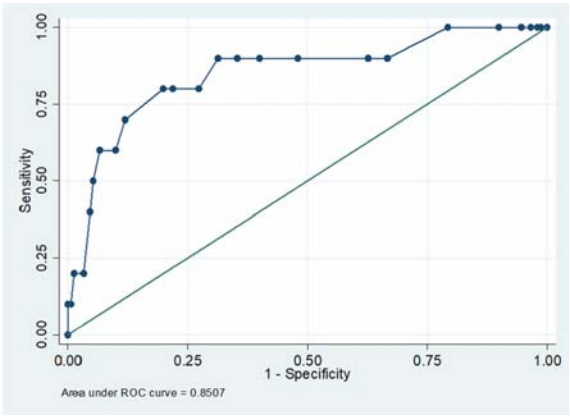

Figure 2. ROC of APACHE-II score for predicting ICU mortality rate.
Show the Receiver Operating Characteristic (ROC) curve for APACHE-II in predicting mortality rate in Ramathibodi SICU.

that significantly effected ICU mortality was non-schedule admission, Sepsis, the presence of acute renal failure and iSOFA more than 3 (Table 4). The iSOFA more than 3 correlated most closely with mortality, whereas APACHE-II more than 10, related to ICU mortality but not statistically significant.

Discussion

The quality of the scoring system used for predictive outcome depended on the efficacy in differentiating the deaths and the surviving ones, was called "Discrimination" and the accuracy of the model in difference levels of risks called "calibration". Even well-accepted models such APACHE-II and SOFA score had moderate discrimination. Moreover, both scoring systems should be validated further due to differences in ICU setting (facility, admission criteria, and competency) and different patient characteristic (type of population, genetic variation)[1-3].

APACHE-II is the world's most widely used severity of illness score, which can predict the risk in percentages of chance of death, using total acute physiology, age, and chronic health score in evaluation. The score based on 5,815 ICU admissions from 13 tertiary care centers. Those score has validated the application in the SICU patient[9]. But there are limitations for APACHE-II including: 1) risk predictions base on the 1979 to 1982 treatment model and which may differ from nowadays, 2) application limited in first 24 hours of admission, 3) difficult to use and less accuracy and reliability[10], and 4) not involving treatment during evaluation.

SOFA score that was used in this study help to generalize the diversity of patients. It was simple and showed good to excellent accuracy and reliability[10] and capable for serial evaluation providing the comparability of treatment

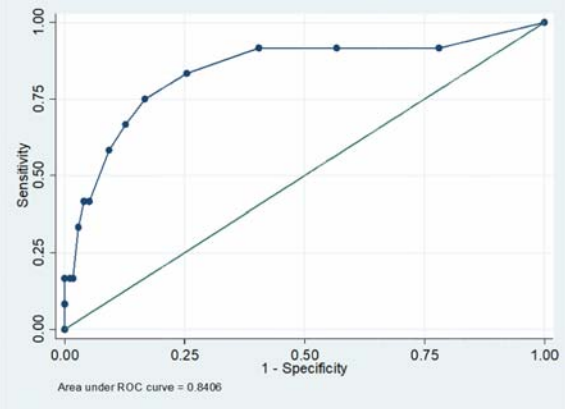

Figure 3. ROC of iSOFA score for predicting ICU mortality rate.
Show the Receiver Operating Characteristic (ROC) curve for iSOFA in predicting mortality rate in Ramathibodi SICU.

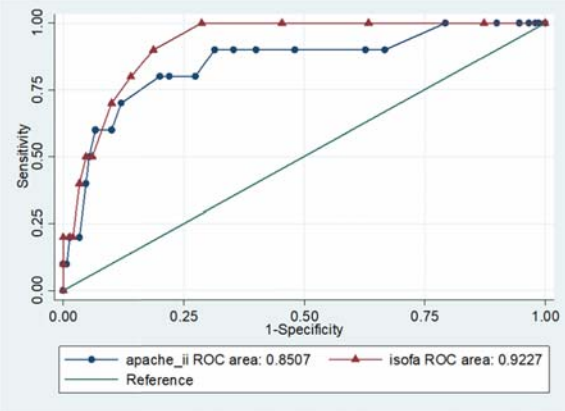

Figure 4. Compared ROC for APACHE-II and iSOFA.
Show the Comparison of ROC curve Between APACHE-II and iSOFA to predicting mortality rate in Ramathibodi SICU.

and natural history of disease[5,6,11,12]. But it also had limitations including: 1) age and chronic illness was denied, 2) establishing of SOFA score based on sepsis European and American patients. Therefore, that may not represent to all clinical courses and the application in Thai population, especially for hepatic component, and 3) for surgical patients, moderate accuracy due to effect from post-anesthetic period or neurologic patients.

The power of discrimination can be evaluated by the ROC, from Strand et al. The mortality had ROC 0.8 were classified in a good prediction model. After excluding the missing data and comparing head-to-head between iSOFA and APACHE-II, we found that iSOFA showed greater ROC, which referred to greater discrimination. But the result may be limited in interpretation due to the small amount in the non-survival group and exclusion of missing data.

From this study, the risk factors for the ICU mortality of iSOFA includes: presence of acute renal failure, non-scheduled admission, and clinical sepsis. APACHE-II of more than 10 may be related to mortality but not statistically significant; this may due to lack of test strength.

For our study the major limitations are the retrospective review, causing missing data of 14%, the low mortality rate due to ICU setting, Ramathibodi SICU had 6.5% compared to 23% from other studies conducted in Thailand[11,13]. It lacks protocol for initial evaluation after ICU admission so not all parameters were collected in all patients. So in future study, we aim to improve the data quality and extend the study in variation of SOFA score and apply for evaluation of the clinical course and outcome affected by treatment modality.

In conclusion, the iSOFA score and APACHE-II are a good prognostic indicator for Ramathibodi SICU. The iSOFA >3, Unscheduled admission, presence of acute renal failure and sepsis are the important risk factors for ICU mortality in Ramathibodi SICU.

What is already known in on this topic?

The scoring system for predicting mortality in ICU is necessary. It can be applied in many aspects such as resource management; patient evaluation and comparison, providing baseline data to evaluate the efficacy in each ICU. Nowadays both APACHE-II and iSOFA are accepted as the standard predictor. However, to adopt these predictors in each ICU setting, we need to validate each model before application.

What this study adds?

The present study has provided the validation of APACHE-II and iSOFA for application in Surgical ICU in Ramathibodi Hospital in which iSOFA is the better predictor than the APACHE-II and also shows that the iSOFA score of more than 3 and APACHE-II of more than 10 are the cut point for predicting the high mortality in risk patients.

Potential conflicts of interest

The authors declare no conflict of interest.

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