

# Correlation of APACHE II and SOFA Scores with Length of Stay in Various Surgical Intensive Care Units

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## ABSTRACT

The aim of this study was to evaluate the usefulness of using Acute Physiology and Chronic Health Evaluation (APACHE) II score and Sequential Organ Failure Assessment (SOFA) score as the predictors of length of stay (LOS) in various surgical intensive care units (ICUs) and to test the hypothesis that the significance of scoring for predicting LOS is greater in specialized surgical ICUs. We scored patients in a non-specialized general surgical ICU ( $n=328$ ) and in a specialized cardiosurgical ICU ( $n=158$ ) consecutively on admission (APACHE II-1<sup>st</sup> day; SOFA-1<sup>st</sup> day) and on third day of stay (APACHE II-3<sup>rd</sup> day; SOFA-3<sup>rd</sup> day) in a 4-month period. LOS and APACHE II/SOFA scores were significantly correlated both on admission and on third day of stay in the general surgical ICU (APACHE II-1<sup>st</sup> day  $r=0.289$ ; SOFA-1<sup>st</sup> day  $r=0.306$ ; APACHE II-3<sup>rd</sup> day  $r=0.728$ ; SOFA-3<sup>rd</sup> day  $r=0.725$ ). LOS and APACHE II on admission were not significantly correlated in the cardiosurgical ICU (APACHE II-1<sup>st</sup> day  $r=0.092$ ), while SOFA on admission and APACHE II and SOFA on third day were significantly correlated (SOFA-1<sup>st</sup> day  $r=0.258$ ; APACHE II-3<sup>rd</sup> day  $r=0.716$ ; SOFA-3<sup>rd</sup> day  $r=0.719$ ). Usefulness of scoring for predicting LOS in ICU varied between different surgical ICUs. Contrary to our hypothesis, scoring had greater value for predicting LOS in the non-specialized general surgical ICU. APACHE II score on admission had no value for predicting LOS in the cardiosurgical ICU.

**Key words:** intensive care units, health status indicators, length of stay, APACHE, SOFA

## Introduction

Scoring in intensive care units (ICUs) has been often used for individual patient or group prediction and for evaluating and comparing the performance of different ICUs<sup>1</sup>. It is shown that Acute Physiology and Chronic Health Evaluation (APACHE) II and Sequential Organ Failure Assessment (SOFA) score could be reliable in predicting length of stay (LOS) in various ICU<sup>2,3</sup>. However, comparison of different ICUs showed significant LOS variations that were attributed to patient and selected institutional characteristics<sup>4</sup>.

The aim of our study was to compare the characteristics of two surgical ICUs (non-specialized, general vs specialized, cardiosurgical) by using APACHE II and SOFA scoring. In this report, we focused on finding out usefulness of using these two scoring systems in predicting LOS in surgical ICUs. We hypothesized that significance

of scoring for predicting LOS is greater in specialized surgical ICUs because the patients have similar characteristics.

## Patients and Methods

The study included all patients consecutively admitted to surgical ICUs in University Hospital Dubrava from November 2004 to February 2005. There have been two types of surgical ICUs in University Hospital Dubrava: a non-specialized surgical ICU, also referred as »general«, and a specialized cardiosurgical ICU. The general ICU admits patients after major abdominal, plastic, maxillofacial, trauma, and neurosurgery; while the specialized cardiosurgical ICU admits patients after cardiac surgery.

**TABLE 1**  
PATIENTS' CHARACTERISTICS

	General surgical ICU (n = 328)		Cardiosurgical ICU (n = 158)	
	n	%	n	%
<b>Gender</b>				
male	211	64.3	117	74.1
female	117	35.7	41	25.9
<b>Type of admission</b>				
nonoperative – from Emergency Department	10	3.0	2	1.3
nonoperative – from ward	20	6.1	0	0
urgent surgery	110	33.5	7	4.4
elective surgery	188	57.3	149	94.3
<b>Type of discharge</b>				
alive	316	97.3	152	96.2
died	12	3.7	6	3.8
	X ± SD	MIN-MAX	X ± SD	MIN-MAX
Age (years)	58.70 ± 17.39	(1-93)	60.97 ± 11.69	(18-78)
ICU LOS (days)	3.69 ± 5.02	(0-52)	4.59 ± 7.74	(2-92)
APACHE II – 1 <sup>st</sup> day	9.31 ± 5.19	(0-34)	8.01 ± 4.72	(1-26)
SOFA – 1 <sup>st</sup> day	2,28 ± 2.25	(0-11)	4.42 ± 2.58	(0-18)
APACHE II – 3 <sup>rd</sup> day	2.02 ± 4.24	(0-27)	1.87 ± 3.57	(0-19)
SOFA – 3 <sup>rd</sup> day	0.78 ± 1.89	(0-17)	1.23 ± 2.38	(0-12)

ICU – intensive care unit

LOS – length of stay

APACHE – Acute Physiology and Chronic Health Evaluation

SOFA – Sequential Organ Failure Assessment

ICU residents scored patients on admission (APACHE II-1<sup>st</sup> day; SOFA-1<sup>st</sup> day) and on third day of stay (APACHE II-3<sup>rd</sup> day; SOFA- 3<sup>rd</sup> day) according to the scoring forms. APACHE II was calculated, as recommended in the reference literature, from 12 physiological variables, with additional weighting for previous health related to urgency on admission, and age<sup>5</sup>. SOFA score was calculated according to its design that evaluates six major organ systems (i.e. cardiovascular, respiratory, renal, hepatic, central nervous system, and coagulation)<sup>6</sup>. Since scoring represents routine activity in ICUs, we did not ask for additional Institution nor patient consent.

Apart from APACHE II and SOFA scores, we collected data on gender, age, type of admission (elective/urgent surgery), type of discharge (alive/died) and length of stay (LOS) in days in ICU.

Data were expressed as mean ± standard deviation (SD). Categorical data were expressed as frequencies and percentages. Unpaired *t* test was used for differences between groups. Association of categorical variables was assessed with  $\chi^2$ -test. Regression analysis was performed to correlate APACHE and SOFA scores with LOS. *P* < 0.05 was considered statistically significant. Statistical analysis was performed with SPSS software for Windows, version 11.0 (SPSS Inc., Chicago, IL, USA).

## Results

The study included 486 patients. Table 1 shows patients' characteristics in the study groups. There was no significant difference between the study groups according to gender (*p*=0.949), age (*p*=0.240), type of admission (*p*=0.568), type of discharge (*p*=0.847), LOS (*p*=0.999), APACHE II-1<sup>st</sup> day (*p*=0.957), SOFA-1<sup>st</sup> day (*p*=0.624), APACHE II-3<sup>rd</sup> day (*p*=1.000), SOFA-3<sup>rd</sup> day (*p*=0.942).

Figures 1-8 show correlation of LOS and APACHE II/SOFA scores.

## Discussion and Conclusion

There is great variability of scoring systems used in surgical intensive care units. The results of our study suggest that usefulness of APACHE II and SOFA scoring for predicting LOS in ICU varied between different types of surgical ICUs and between times when the scores were calculated. Contrary to our hypothesis, APACHE II and SOFA scoring had greater value for predicting LOS in general, non-specialized surgical ICU. Moreover, APACHE II score on admission had no value for predicting LOS in the specialized cardiosurgical ICU. On third day, correlations of both scores were similar and greater in both

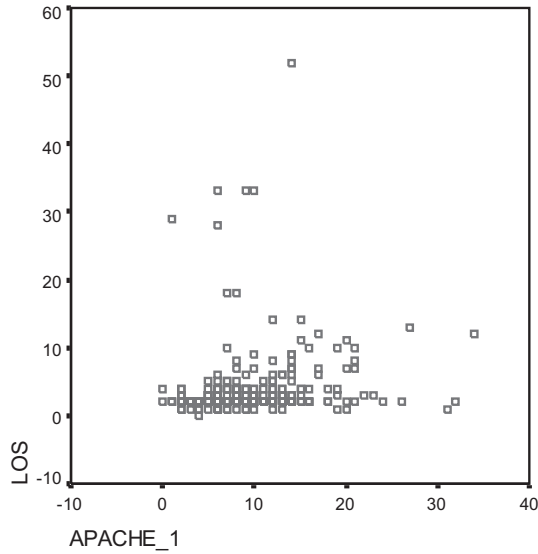


Fig. 1. Correlations APACHE II – 1<sup>st</sup> day and LOS (in days) in general surgical ICU.  
 Pearson  $r=0.144$ ,  $p=0.09$ ;  $R^2=0.021$   
 Spearman's rho coefficient  $0.289$ ,  $p<0.001$   
 $y=0.139x+2.395$

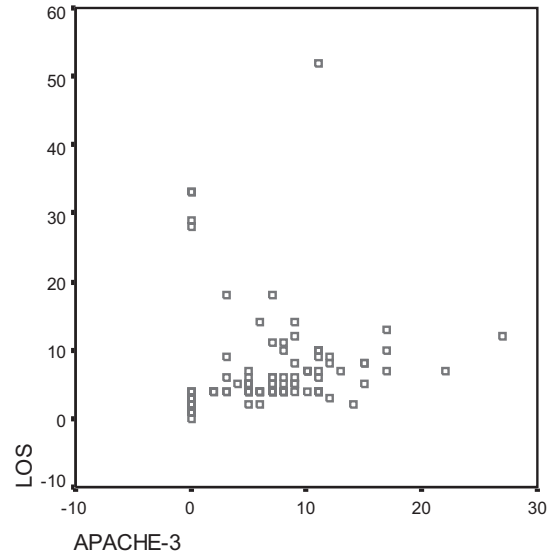


Fig. 3. Correlations APACHE II – 3<sup>rd</sup> day and LOS (in days) in general surgical ICU.  
 Pearson  $r=0.367$ ,  $p<0.001$ ;  $R^2=0.135$   
 Spearman's rho coefficient  $=0.728$ ,  $p<0.001$   
 $y=0.435x+2.813$

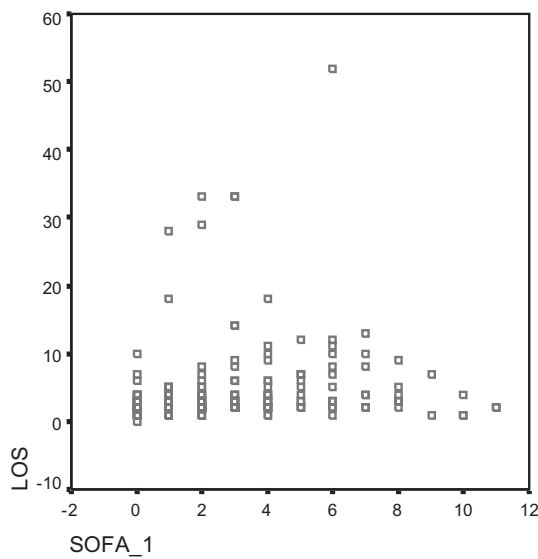


Fig. 2. Correlations SOFA – 1<sup>st</sup> day and LOS (in days) in general surgical ICU.  
 Pearson  $r=0.189$ ,  $p=0.001$ ;  $R^2=0.036$   
 Spearman's rho coefficient  $=0.306$ ,  $p<0.001$   
 $y=0.422x+2.727$

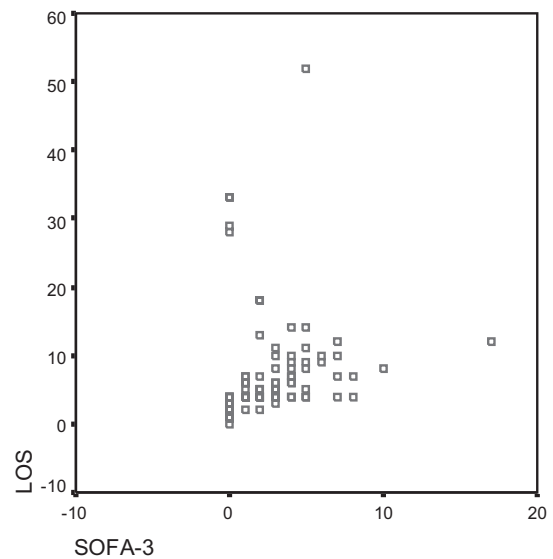


Fig. 4. Correlations SOFA – 3<sup>rd</sup> day and LOS (in days) in general surgical ICU.  
 Pearson  $r=0.368$ ,  $p<0.001$ ;  $R^2=0.136$   
 Spearman's rho coefficient  $=0.725$ ,  $p<0.001$   
 $y=0.978x+2.926$

types of surgical ICUs when compared to values on admission.

The possible explanation for these, at first, surprising results may be that the starting hypothesis was wrong. We had been focused on patients' characteristics as the main difference between the studied surgical ICUs. However, patients in our study were comparable in basic characteristics, including the absolute scores values. There

were different surgical postoperative intensive care interventions, and not the patients.

These different interventions were most obvious at admission. According to the standard procedure, all cardio-surgical patients received haemodynamic support on admission. It is well known that the APACHE II score has no adjustments for the use of haemodynamic support, while the SOFA score does<sup>7</sup>. This explains the no-

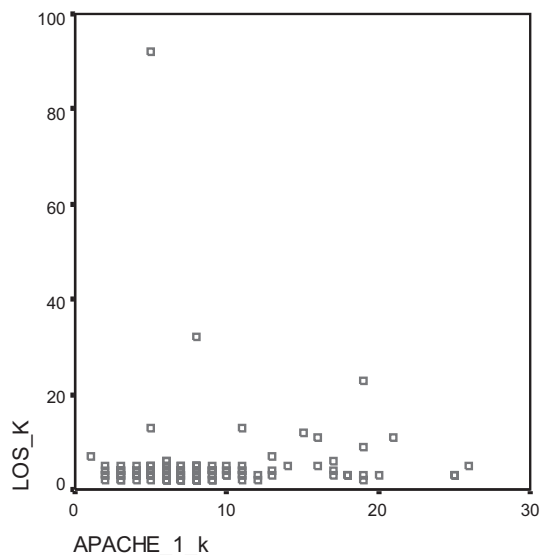


Fig. 5. Correlations APACHE II – 1<sup>st</sup> day and LOS (in days) in cardio-surgical ICU.  
 Pearson  $r=0.045$ ,  $p=0.573$ ;  $R^2=0.02$   
 Spearman's rho coefficient  $0.092$ ,  $p=0.249$   
 $y=0.074x+4.002$

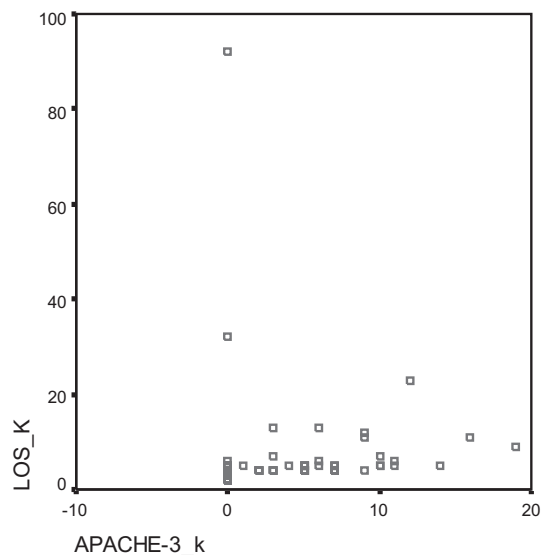


Fig. 7. Correlations APACHE II – 3<sup>rd</sup> day and LOS (in days) in cardio-surgical ICU.  
 Pearson  $r=0.150$ ,  $p=0.06$ ;  $R^2=0.022$   
 Spearman's rho coefficient  $0.716$ ,  $p<0.001$   
 $y=0.324x+3.990$

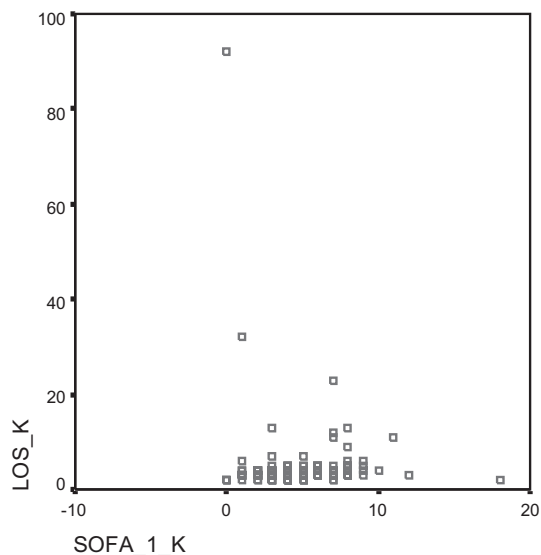


Fig. 6. Correlations SOFA – 1<sup>st</sup> day and LOS (in days) in cardio-surgical ICU.  
 Pearson  $r=-0.073$ ,  $p=0.363$ ;  $R^2=0.05$   
 Spearman's rho coefficient  $=0.258$ ,  $p=0.01$   
 $y=-0.218x+5.559$

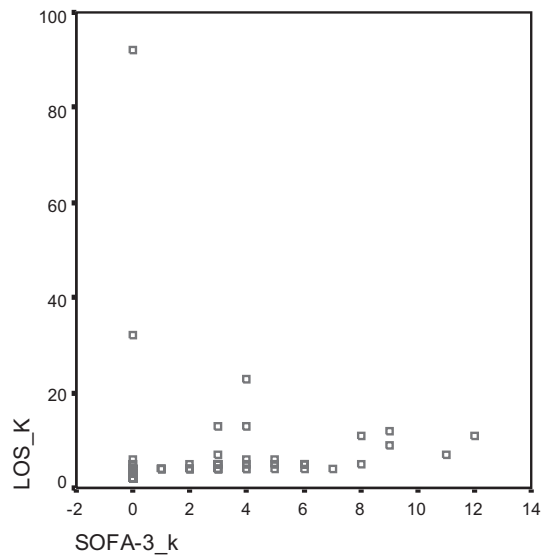


Fig. 8. Correlations SOFA – 3<sup>rd</sup> day and LOS (in days) in cardio-surgical ICU.  
 Pearson  $r=0.141$ ,  $p=0.078$ ;  $R^2=0.02$   
 Spearman's rho coefficient  $0.719$ ,  $p<0.001$   
 $y=0.456x+4.032$

ticed difference at admission between the studied ICUs. Unfortunately, we did not include ICU interventions' details in the study design and did not collect data on them prospectively to make analysis that could merit further discussion.

LOS is commonly used as a measure of cost and for adequate assessing unit efficiency<sup>4</sup>. It would be beneficial to use score on admission that would predict the LOS re-

liably. Siddiqui et al. strongly claimed in their study that APACHE II on admission is reliable predictor of LOS in ICU<sup>2</sup>. Our results were opposite. Unfortunately, the authors did not specify the type of their surgical ICU. Engle et al. reported correlation of LOS and an admission SOFA similar to our results<sup>3</sup>. Again, the authors did not specify the types of surgical ICUs. However, the same authors derived SOFA measures by adding information of illness

and therapeutic interventions that improved the correlation with LOS compared to the »admission SOFA«<sup>3</sup>.

The present study demonstrated that APACHE II and SOFA can be used as predictors of LOS in surgical ICUs,

but with limitations. We would not recommend using APACHE II score in cardiothoracic ICUs. We would suggest that specialized surgical ICUs develop and use only the scores that include specific therapeutic interventions.

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## POVEZANOST BODOVNIH SUSTAVA APACHE II I SOFA S DULJINOM BORAVKA U RAZLIČITIM KIRURŠKIM JEDINICAMA ZA INTENZIVNO LIJEČENJE

### SAŽETAK

U ovom istraživanju procijenjivali smo korisnost uporabe bodovnih sustava APACHE II (*acute physiology and chronic health evaluation*) i SOFA (*sequential organ failure assessment*) u predviđanju duljine boravka u različitim kirurškim jedinicama za intenzivno liječenje. Dodatno smo ispitivali hipotezu da je značenje bodovanja veće u specijaliziranim kirurškim jedinicama za intenzivno liječenje. U istraživanje smo susljedno uključili bolesnike iz nespecijalizirane kirurške jedinice za intenzivno liječenje ( $n=328$ ) i iz jedinice specijalizirane za intenzivno liječenje bolesnika iz kardiokirurgije ( $n=158$ ). U promatranom četveromjesečnom razdoblju svim bolesnicima je pri prijemu i treći dan boravka u jedinici za intenzivno liječenje određen APACHE II i SOFA bod. Utvrdili smo značajnu povezanost duljine boravka i APACHE II / SOFA bodova pri prijemu i treći dan boravka u kirurškoj nespecijaliziranoj jedinici za intenzivno liječenje (APACHE II-1.dan  $r=0,289$ ; SOFA-1.dan  $r=0,306$ ; APACHE II-3.dan  $r=0,728$ ; SOFA-3.dan  $r=0,725$ ). Duljina boravka i APACHE II pri prijemu nisu bili značajno povezani u jedinici za intenzivno liječenje kardiokirurških bolesnika (APACHE II-1.dan  $r=0,092$ ). Ipak, i u jedinici za intenzivno liječenje kardiokirurških bolesnika, duljina boravka je bila značajno povezana sa SOFA bodom pri prijemu te APACHE II i SOFA bodovima treći dan boravka (SOFA-1.dan  $r=0,258$ ; APACHE II-3.dan  $r=0,716$ ; SOFA-3.dan  $r=0,719$ ). Korisnost bodovanja u svrhu predviđanja duljine boravka u različitim kirurškim jedinicama za intenzivno liječenje je varijabilna. Suprotno našoj postavljenoj hipotezi, uporaba bodovnih sustava APACHE II i SOFA se pokazala značajnijom u nespecijaliziranoj kirurškoj jedinici za intenzivno liječenje. APACHE II bod pri prijemu nije imao značenje u kardiokirurškoj jedinici za intenzivno liječenje.