

Comparison of Severity of Illness Scoring Systems for Patients with Nosocomial Bloodstream Infection due to *Pseudomonas aeruginosa*

ABSTRACT

Background: Several acute illness severity scores have been proposed for rating patients on admission to intensive care units but these have not been compared for patients with nosocomial bloodstream infection (nBSI).

Objective: To compare three severity of illness scoring systems for predicting mortality in patients with nBSI due to *P. aeruginosa*.

Methods: We performed a historical cohort study on 57 adults with *P. aeruginosa* nBSI. The acute physiology, age, chronic health evaluation II (APACHE II), Sequential Organ Failure Assessment (SOFA), and simplified acute physiologic score (SAPS II), were calculated daily from 2 days prior through 14 days after the positive blood culture. Discrimination was tested by using the area under a receiver operating characteristic (ROC) curve at -2, -1, 0, 1 and 2 days (day of onset = 0). Sensitivity, specificity, overall correctness of prediction, and positive and negative predictive values for APACHE II (AP2), SAPS II (S2) and SOFA scores were determined. The cut-off points were identified as the score that gave the best Youden index (sensitivity + specificity - 1) for each scoring system.

Results: The overall hospital mortality rate was 45.6%. Median AP2, S2 and SOFA scores on the day of BSI were 22, 41 and 6, respectively. The AP2 and S2 scores showed good areas under the receiver operating characteristic curve (0.785±0.061 and 0.756±0.064, respectively) at day 0, whereas SOFA demonstrated the best curve at day 1 (0.784±0.062). On day 0, the best Youden index and the highest overall correctness of prediction was found for the AP2 (0.785) and SAPS II (0.756) scores. The sensitivity was similar for all scores (AP2 92.3%, S2 96.2%, SOFA 92.3%). In-hospital mortality rates below and above a cut-off of 19 AP2 points (10.0% (2/20) and 64.9% (24/37) (p<0.001), for a cut-off of 33 S2 points (6.25% (1/16) and 61.0% (25/41) (p<0.001), and for 4 SOFA points 12.5% (1/8) and 58.5% (24/41) (p=0.003).

Conclusions: 1) The crude mortality rate is high for *P. aeruginosa* BSI; 2) AP2 is more accurate than S2 and SOFA scores for predicting mortality in this group of patients.

INTRODUCTION

Since the development of the APACHE (Acute Physiological and Chronic Health Evaluation) II score, many studies of infectious diseases have used this scoring system to characterize the patient's severity of illness. Several studies of illness severity scores have been proposed for evaluating patients on admission to intensive care units (SAPS II and SOFA) but these have not been compared for patients with nosocomial bloodstream infection (nBSI).

Pseudomonas aeruginosa has the highest crude mortality among bacteria causing nosocomial BSI. Some small studies have evaluated the effect of different pathogens in relation to clinical outcome. However, there is not a consensus in scoring systems for evaluating prognosis in BSI. The purpose of our study was to compare three severity of illness scoring systems for predicting mortality in patients with nBSI due to *Pseudomonas aeruginosa*.

METHODS

Setting: The Virginia Commonwealth University Medical Center is a 820-bed tertiary care facility in Richmond, Virginia. The hospital houses 9 intensive care units and a burn unit; approximately 30,000 patients are admitted annually.

Study design: Historical cohort study of 57 randomly selected patients with monomicrobial *P. aeruginosa* nBSI from 1996-2003. The clinical condition of each patient was classified according to systemic inflammatory response syndrome (SIRS) criteria [SIRS, sepsis, severe sepsis or septic shock] and APACHE II scores from two days prior to positive blood culture through 14 days afterwards.

Statistical methods: For continuous variables, mean values were compared using two sample t-tests for independent samples. Differences in proportions were compared using a Chi-square test or Fisher's Exact Test when appropriate. Mean values are reported ± 1 SD. Discrimination was tested by using the area under a receiver operating characteristic (ROC) curve at -2, -1, 0, 1 and 2 days (day of BSI onset = 0). Sensitivity, specificity, overall correctness of prediction, and positive and negative predictive values for APACHE II (AP2), SAPS II (S2) and SOFA scores were determined. The cut-off points for predicting mortality were identified as the score giving the best Youden index (sensitivity + specificity - 1) for each scoring system. The Youden index evaluates the diagnostic efficacy of a test. If the index is equal or below 0, the diagnostic efficacy of the test is poor. On the other hand, the closer it is to 1, the higher is its diagnostic value. All tests of significance are two-tailed. Alpha was set at 0.05. All statistical analyses were done using the Statistical Package for the Social Sciences software (SPSS, Chicago, IL, USA).

RESULTS

Table 1: Comparison of variables collected in APACHE II, SAPS II and SOFA scores.

	APACHE II	SAPS II	SOFA
Temperature	x	x	
Mean arterial pressure	x		
Systolic BP		x	
Vasopressor dose			x
Heart rate	x	x	
Respiratory rate	x		
Oxygenation A-aDO ₂ or PaO ₂	x		x
a.FIO ₂ ≥ 0.5 record A-aDO ₂			
b.FIO ₂ < 0.5 record only PaO ₂			
PaO ₂		x*	
Arterial pH	x		
Serum sodium	x	x	
Serum potassium	x	x	
Urinary output		x	
Serum creatinine	x		x**
Serum urea level		x	x**
Hematocrit	x		
White blood count	x	x	
Glasgow Coma Score	x	x	x
Serum HCO ₃	only if no ABGs	x	
Bilirubin level		x	x
Age, years	x	x	
Chronic diseases		x	
Chronic health points (APACHE II)/type of admission (SAPS II)	x	x	
Platelets			x

APACHE II score ranges 0-71; SAPS II score ranges 0-146; SOFA score ranges 0-24
 * If identified as continuous pulmonary arterial pressure
 ** Creatinine or urine output
 ABG - Arterial Blood Gas

Figure 1: Receiver operating characteristic curves at day of BSI (day 0) for APACHE II (red; area under ROC curve is 0.785), SAPS II (green; area under ROC curve is 0.756) and SOFA (blue; area under ROC curve is 0.725).

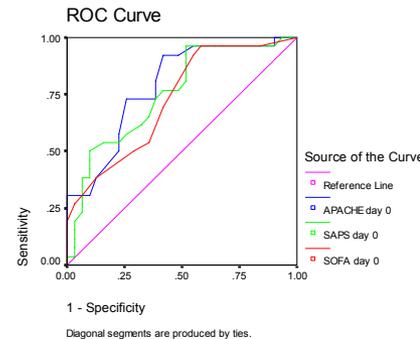


Table 2: Comparison between receiver operating characteristic (ROC) curves for APACHE II, SAPS II and SOFA scores at days -2, -1, 0, 1 and 2 of *P. aeruginosa* BSI.

DAYS of BSI	AREA UNDER ROC CURVE				
	-2	-1	0	1	2
APACHE II	0.685	0.777	0.785	0.784	0.765
SAPS II	0.723	0.741	0.756	0.753	0.73
SOFA	0.677	0.718	0.725	0.784	0.75

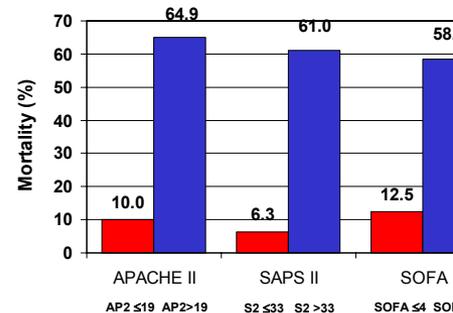
RESULTS (continued)

Table 3: Prediction of subsequent hospital mortality determined on day of *P. aeruginosa* BSI

SCORING SYSTEM	Cut-off point*	Youden Index	Sensitivity (%)	Specificity (%)	Overall correctness (%)	PPV (%)
APACHE II	19	0.504	92.3	58.1	73.7	64.9
SAPS II	33	0.446	96.2	51.6	70.2	61.0
SOFA	4	0.375	92.3	45.2	66.7	58.5

PPV= positive predictive value, NPV=negative predictive value, * =value giving the best Youden index.

Figure 2: Mortality rates at the cut-off point for APACHE II, SAPS II and SOFA at day 0 of BSI



CONCLUSIONS

- The crude mortality rate is high for *P. aeruginosa* BSI.
- APACHE II is more accurate than SAPS II and SOFA scores for predicting mortality in this group of patients.



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