Prospective cohort study comparing sequential organ failure assessment and acute physiology, age, chronic health evaluation III scoring systems for hospital mortality prediction in critically ill cirrhotic patients

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SUMMARY
The aim of the study was to evaluate the usefulness of sequential organ failure assessment (SOFA) and acute physiology, age, chronic health evaluation III (APACHE III) scoring systems obtained on the first day of intensive care unit (ICU) admission in predicting hospital mortality in critically ill cirrhotic patients. The study enrolled 102 cirrhotic patients consecutively admitted to ICU during a 1-year period. Twenty-five demographic, clinical and laboratory variables were analysed as predictors of survival. Information considered necessary to calculate the Child–Pugh, SOFA and APACHE III scores on the first day of ICU admission was also gathered. Overall hospital mortality was 68.6%. Multiple logistic regression analysis revealed that mean arterial pressure, SOFA and APACHE III scores were significantly related to prognosis. Goodness-of-fit was good for the SOFA and APACHE III models. Both predictive models displayed a similar degree of the best Youden index (0.68) and overall correctness (84%) of prediction. The SOFA and APACHE III models displayed good areas under the receiver–operating characteristic curve (0.917 ± 0.028 and 0.912 ± 0.029, respectively). Finally, a strong and significant positive correlation exists between SOFA and APACHE III scores for individual patients ($r^2 = 0.628$, $p < 0.001$). This investigation confirms the grave prognosis for cirrhotic patients admitted to ICU. Both SOFA and APACHE III scores are excellent tools to predict the hospital mortality in critically ill cirrhotic patients. The overall predictive accuracy of SOFA and APACHE III is superior to that of Child–Pugh system. The role of these scoring systems in describing the dynamic aspects of clinical courses and allocating ICU resources needs to be clarified.

Keywords: Cirrhosis; SOFA; APACHE III; Child–Pugh; ICU

INTRODUCTION
Patients with cirrhosis who develop extrahepatic organ failure still have a poor prognosis; such cases lead the list of causes of death in intensive care units (ICU) (1–3). In treating critically ill cirrhotic patients, objective severity assessment is important in determining therapeutic approach, comparing the benefits of various treatments, assessing new therapeutic procedures, comparing treatment success rates among medical centres and explaining the patient’s condition to the family members.

In 1964, Child and Turcotte designed a prognostic system for assessing surgical risk in cirrhotic patients with bleeding oesophageal varices. This system was later modified by Pugh et al. in 1973 (4). The Child–Pugh scoring system has been widely used to risk stratify cirrhotic patients and assess the efficiency of therapeutic procedures such as sclerotherapy, band ligation of varices, transjugular intrahepatic portosystemic shunt (TIPS) and surgery (5–7). However, the application of the Child–Pugh scoring system has encountered setbacks owing to interobserver variation for subjective criteria and the failure to assess extrahepatic prognostic factors such as cardiovascular, renal and pulmonary functions. The acute physiology and chronic health evaluation (APACHE) III (8), introduced in 1991, includes a much larger database, extended disease categories, increased weighing of acute physiologic variables and reduced weighing of chronic illness. As estimated, APACHE III predicts mortality with an accuracy of 90%. More recently, sequential organ failure assessment...
APACHE III and SOFA, with normal function being scored conservatively as the neurologic component of the ICU admission was also recorded. The Glasgow–Coma Scale value of each of the six organ systems on the first day of defined as in the original report (9). The most abnormal function was assessed using SOFA, and SOFA score was physiological values on the first day of ICU admission. Organ where (8). Physiological calculations employed the worst APACHE III score, which was calculated as described elsewhere on the first day of ICU admission, length of stay and for ICU admission, acute diagnosis, illness severity, organ function had received prior liver transplant and readmissions.

Exclusion criteria contained a total of 102 consecutive patients with hepatic Taiwan, between January and December 2004. The sample comprised the troenterology ICU of a 2000-bed university hospital in Given the promising new treatment and limited medical resources, investigators and physicians require a reliable tool to risk stratify and monitor patients during practice and clinical trials. Consequently, this investigation was conducted to validate the effectiveness of these scoring systems in predicting the hospital mortality of critically ill cirrhotic patients based on score assessments taken on the first day of ICU admission.

**MATERIALS AND METHODS**

**Patient Information and Data Collection**

This investigation was performed in a 10-bed specialised gastroenterology ICU of a 2000-bed university hospital in Taiwan, between January and December 2004. The sample contained a total of 102 consecutive patients with hepatic cirrhosis requiring intensive monitoring and/or treatment that could not be provided outside of the ICU. Exclusion criteria included paediatric patients (18 years or younger), patients who had received prior liver transplant and readmissions.

Prospectively gathered data included demographics, reason for ICU admission, acute diagnosis, illness severity, organ function on the first day of ICU admission, length of stay and outcome. The main study outcome was hospital mortality rate.

**Definitions**

Liver disease severity at ICU admission was graded using the Child–Pugh system (4). Illness severity was assessed using APACHE III score, which was calculated as described elsewhere (8). Physiological calculations employed the worst physiologic values on the first day of ICU admission. Organ function was assessed using SOFA, and SOFA score was defined as in the original report (9). The most abnormal value of each of the six organ systems on the first day of ICU admission was also recorded. The Glasgow–Coma Scale scored conservatively as the neurologic component of the APACHE III and SOFA, with normal function being assumed for sedated patients unless evidence of intrinsically altered neurologic function existed.

**Statistical Analysis**

Descriptive statistics are expressed as mean ± SE. The main analysis compared hospital survivors with non-survivors. All variables were tested for normal distribution using the Kolmogorov–Smirnov test, the Student’s t-test was used to compare the means of continuous variables and normal distribution data, and otherwise the Mann–Whitney U-test was used. Categorical data were tested using χ² analysis. Additionally, risk factors were assessed using univariate analysis, and variables that were statistically significant (p < 0.05) in the univariate analysis were included in the multivariate analysis by applying a multiple logistic stepwise Cox-regression procedure to obtain variables that independently correlated with survival (13). Correlation of paired variables within groups was assessed using linear regression with Pearson analysis.

Calibration was assessed using the Hosmer–Lemeshow goodness-of-fit test (C statistic), which compares the number of observed and predicted deaths in risk groups for the entire range of probabilities of death. The expected or predicted number of non-survivors was determined by totalling the predicted mortality risks of all individuals for roughly equal numbers of patients; meanwhile, the expected number of survivors was simply the total number of individuals with approximately equal numbers of patients minus the expected number of non-survivors. The χ² equals the sum of the squared difference between the observed and the expected numbers, divided by the expected number Σ(E – O)²/E. A high value suggested poor calibration, while a small value suggested good calibration (14).

Discrimination (i.e., model ability to distinguish between dying and living patients) was tested using the area under a receiver–operating characteristic (ROC) curve (15,16). When a model performance resembles coin flipping, the area under an ROC curve approaches 0.5, but as the area approaches 1.0 the model approaches 100% sensitivity and specificity regardless of the cut-off point.

ROC analysis was also performed to calculate the cut-off values, sensitivity, specificity, overall correctness and positive and negative predictive values. The best cut-off point was determined when the point yielded the best specificity and sensitivity in the ROC analysis. Moreover, the best Youden index (sensitivity + specificity − 1) (17) was also used to determine the best cut-off point. The Youden index was used to compare the proportion of cases correctly classified. A high Youden index indicated an accurate prediction (more true-positives and -negatives and fewer false-positives and -negatives at the cut-off point).

All statistical tests were two-tailed, and a significance level of p = 0.05 or less was used. Data were analysed using SPSS 10.0 for Windows 95 (SPSS Inc., Chicago, IL, USA).
RESULTS

Subject Characteristics

This investigation enrolled 102 cirrhotic patients treated in the specialised hepatogastroenterology ICU from January to December 2004. The median age was 61 years, 76 (74.5%) of the sample were males and 26 (25.5%) were females. In-hospital mortality for the total group was 68.6%. Table 1 lists the patient demographic data, along with the clinical characteristics of both survivors and non-survivors, while Table 2 presents cause of cirrhosis and reasons for ICU admission. Liver disease was generally attributed to

| Table 1 | Patients’ demographic data and clinical characteristics |
|---------|--------------------------------------------------------|
|         | All patients (n = 102) | Survivors (n = 32) | Non-survivors (n = 70) | p-value |
| Age (years) | 58 ± 1 | 58 ± 3 | 58 ± 1 | NS (0.970) |
| Gender (male/female) | 76/26 | 25/7 | 51/19 | NS (0.571) |
| Length of ICU stay (days) | 6.4 ± 0.5 | 4.8 ± 0.5 | 7.1 ± 0.6 | 0.003 |
| Length of hospital stay (days) | 17.2 ± 1.2 | 18.3 ± 2.0 | 16.6 ± 1.5 | NS (0.503) |
| Diabetes mellitus [n (%)] | 29 (28) | 6 (19) | 23 (33) | NS (0.143) |
| Previous ascites [n (%)] | 51 (50) | 16 (50) | 35 (50) | NS (0.001) |
| Previous SBP [n (%)] | 19 (19) | 5 (16) | 14 (20) | NS (0.598) |
| Hepatic encephalopathy, ICU first day [n (%)] | 59 (58) | 14 (44) | 45 (64) | NS (0.051) |
| EV bleeding, ICU first day [n (%)] | 49 (48) | 17 (53) | 32 (46) | NS (0.487) |
| Peptic ulcer bleeding, ICU first day [n (%)] | 42 (41) | 12 (38) | 30 (43) | NS (0.610) |
| Hepatoma [n (%)] | 34 (33) | 10 (31) | 24 (34) | NS (0.763) |
| Previous renal failure [n (%)] | 29 (28) | 8 (25) | 21 (30) | NS (0.603) |
| Bilirubin, ICU first day (mg/dl) | 10.5 ± 1.1 | 4.8 ± 1.0 | 13.1 ± 1.5 | <0.001 |
| Albumin, ICU first day (g/l) | 2.4 ± 0.5 | 2.6 ± 0.1 | 2.3 ± 0.1 | 0.019 |
| Prothrombin time prolongation, ICU first day (s) | 12.2 ± 1.8 | 5.7 ± 1.2 | 15.7 ± 2.6 | 0.001 |
| AST, ICU first day (U/l) | 497 ± 146 | 209 ± 65 | 618 ± 204 | NS (0.060) |
| ALT, ICU first day (U/l) | 238 ± 66 | 76 ± 35 | 305 ± 91 | 0.021 |
| Platelets, ICU first day (x10^9/l) | 97 ± 8 | 96 ± 11 | 98 ± 11 | NS (0.925) |
| Leucocytes, ICU first day (x10^9/l) | 11.9 ± 0.8 | 9.6 ± 1.3 | 12.9 ± 0.9 | 0.046 |
| Haemoglobin, ICU first day (g/dl) | 8.9 ± 0.2 | 8.3 ± 0.3 | 9.1 ± 0.3 | NS (0.114) |
| Serum creatinine, ICU first day (mg/dl) | 2.9 ± 0.2 | 1.9 ± 0.4 | 3.3 ± 0.3 | 0.003 |
| MAP on ICU admission (mmHg) | 72 ± 2 | 83 ± 3 | 67 ± 2 | <0.001 |
| Child–Pugh points (mean ± SE) | 11.2 ± 0.2 | 9.9 ± 0.4 | 11.8 ± 0.2 | <0.001 |
| APACHE III (mean ± SE) | 102.4 ± 4.1 | 62.7 ± 4.5 | 120.5 ± 4.1 | <0.001 |
| SOFA (mean ± SE) | 10.7 ± 0.4 | 6.6 ± 0.5 | 12.6 ± 0.4 | <0.001 |

NS, not significant; ICU, intensive care unit; SBP, spontaneous bacterial peritonitis; EV, oesophageal varices; AST, aspartate aminotransferase; ALT, alanine aminotransferase; MAP, mean arterial pressure; SE, standard error; APACHE, acute physiology and chronic health evaluation; SOFA, sequential organ failure assessment.

Table 2 Causes of cirrhosis and reasons for ICU admission

| Cause of cirrhosis | All patients [n (%)] | Hospital survivors [n (%)] | Hospital non-survivors [n (%)] | p-value |
|--------------------|----------------------|---------------------------|-------------------------------|---------|
| Alcoholic          | 26 (25)              | 13 (41)                   | 13 (19)                       | 0.008   |
| Hepatitis B        | 49 (48)              | 7 (22)                    | 42 (60)                       | 0.001   |
| Hepatitis C        | 20 (20)              | 8 (25)                    | 12 (17)                       | NS (0.541) |
| Other causes *     | 7 (7)                | 4 (12)                    | 3 (4)                         | NS (0.419) |
| Primary ICU admission |                     |                           |                               |         |
| Severe UGI bleeding| 41 (40)              | 20 (63)                   | 21 (30)                       | 0.002   |
| Severe sepsis      | 24 (23)              | 1 (3)                     | 23 (33)                       | 0.001   |
| Hepatic encephalopathy | 19 (19)             | 9 (28)                    | 10 (14)                       | NS (0.096) |
| Respiratory failure| 7 (7)                | 1 (3)                     | 6 (9)                         | NS (0.313) |
| Acute renal failure require renal replacement | 6 (6) | 1 (3) | 5 (7) | NS (0.424) |
| Hepatoma rapture   | 74 (74)              | 0 (0)                     | 4 (6)                         | NS (0.168) |
| Acute pancreatitis | 71 (1)               | 0 (0)                     | 1 (1)                         | NS (0.497) |

ICU, intensive care unit; NS, not significant; UGI, upper gastrointestinal. *Primary biliary cirrhosis, autoimmune hepatitis.
hepatitis B viral infection, and the most common reason for ICU admission was upper gastrointestinal bleeding.

**Risk Factors for Hospital Mortality**

Eight of the 25 variables had prognostic value in the univariate analysis (Table 3). Meanwhile, the multivariate analysis identified the following variables as having independent prognostic significance: mean arterial pressure, APACHE III and SOFA (Table 3). The regression coefficients of these variables were used as a basis for calculating a logit of death for each patient, as follows:

\[
\text{The logarithm of the odds of mortality} = -3.13 - 0.059 \times \text{mean arterial pressure (in mmHg)} + 0.053 \times \text{APACHE III score} + 0.424 \times \text{SOFA score}.
\]

**Mortality and Severity of Illness Scoring Systems**

For assessing goodness-of-fit, as measured by the Lemeshow–Hosmer \( \chi^2 \) statistic of predicted mortality risk, the calibration of SOFA (Lemeshow–Hosmer \( \chi^2 = 5.006 \) \( df = 8 \), \( p = 0.757 \)) and APACHE III (Lemeshow–Hosmer \( \chi^2 = 10.392 \) \( df = 8 \), \( p = 0.239 \)) (Table 4) was superior to that of Child–Pugh (Lemeshow–Hosmer \( \chi^2 = 12.365 \) \( df = 5 \), \( p = 0.03 \)).

The model ROC curve displays the true-positive and false-positive rates on the vertical and horizontal axes, respectively (Figure 1). Calculation of the area under the ROC curve confirmed that SOFA (area = 0.917 \( \pm \) 0.028 \( \text{[mean} \pm \text{SEM]} \)) and APACHE III (area = 0.912 \( \pm \) 0.029 \( \text{[95\% CI: 0.856–0.968]} \)) achieved better discrimination than Child–Pugh (area = 0.737 \( \pm \) 0.057 \( \text{[95\% CI: 0.625–0.849]} \)).

**Table 3** Variables showing prognostic significance

| Parameter | Beta coefficient | Standard error | Odds ratio (95% CI) | p-value |
|-----------|------------------|----------------|---------------------|---------|
| Length of ICU stay (days) | 0.147 | 0.064 | 1.16 (1.02–1.31) | 0.021 |
| Bilirubin, ICU first day (mg/dl) | 0.117 | 0.039 | 1.12 (1.04–1.22) | 0.003 |
| Prothrombin time prolongation, ICU first day (s) | 0.137 | 0.048 | 1.15 (1.04–1.26) | 0.005 |
| Serum creatinine, ICU first day (mg/dl) | 0.447 | 0.162 | 1.56 (1.14–2.15) | 0.006 |
| MAP on ICU admission (mmHg) | -0.052 | 0.015 | 0.95 (0.92–0.98) | <0.001 |
| Child–Pugh points | 0.420 | 0.114 | 1.52 (1.22–1.90) | <0.001 |
| APACHE III | 0.067 | 0.014 | 1.07 (1.04–1.10) | <0.001 |
| SOFA | 0.748 | 0.161 | 2.11 (1.54–2.90) | <0.001 |

**Multivariate logistic regression**

| Parameter | Beta coefficient | Standard error | Odds ratio (95% CI) | p-value |
|-----------|------------------|----------------|---------------------|---------|
| MAP on ICU admission (mmHg) | -0.059 | 0.026 | 0.94 (0.90–0.99) | 0.023 |
| APACHE III | 0.053 | 0.022 | 1.05 (1.01–1.10) | 0.017 |
| SOFA | 0.424 | 0.198 | 1.53 (1.04–2.25) | 0.032 |
| Constant | -3.130 | 2.179 | – | – |

ICU, intensive care unit; MAP, mean arterial pressure; CI, confidence interval; APACHE, acute physiology and chronic health evaluation; SOFA, sequential organ failure assessment.

**Table 4** Hosmer–Lemeshow goodness-of-fit statistics for SOFA and APACHE III

| SOFA | APACHE III |
|------|------------|
| **Predicted deciles of mortality (%)** | **Survived** | **Died** | **Survived** | **Died** |
| n | Observed | Expected | Observed | Expected | n | Observed | Expected | Observed | Expected |
|------|------------|------------|------------|------------|------|------------|------------|------------|------------|
| 0–10 | 11 | 11.560 | 0 | 0.440 | 10 | 10 | 9.363 | 0 | 0.637 |
| >10–20 | 10 | 7.036 | 3 | 1.964 | 10 | 6 | 8.017 | 4 | 1.983 |
| >20–30 | 11 | 5.976 | 4 | 5.024 | 9 | 8 | 5.411 | 1 | 3.589 |
| >30–40 | 7 | 2.522 | 5 | 4.478 | 10 | 3 | 3.938 | 7 | 6.062 |
| >40–50 | 14 | 2.948 | 12 | 11.052 | 10 | 1 | 2.579 | 9 | 7.421 |
| >50–60 | 12 | 1.345 | 9 | 10.655 | 10 | 3 | 1.497 | 7 | 8.503 |
| >60–70 | 11 | 0.505 | 11 | 10.495 | 10 | 1 | 0.723 | 9 | 9.277 |
| >70–80 | 8 | 0.078 | 8 | 7.922 | 10 | 0 | 0.325 | 10 | 9.675 |
| >80–90 | 10 | 0 | 0.027 | 10 | 9.797 | 10 | 0 | 0.124 | 10 | 9.876 |
| >90–100 | 8 | 0 | 0.002 | 8 | 7.998 | 13 | 0 | 0.024 | 13 | 12.976 |

\[ \Sigma (E - O)^2 E \]

\[ \chi^2 = 5.006, df = 8, p = 0.757 \]

\[ \chi^2 = 10.392, df = 8, p = 0.239 \]

APACHE, acute physiology and chronic health evaluation; SOFA, sequential organ failure assessment; n, total number of patients per decile; E, expected number of deaths; O, observed number of deaths; df, degrees of freedom.
Next, the correlation between SOFA and APACHE III scores was examined. SOFA and APACHE III strongly and positively correlated with each other in terms of likelihood of hospital death. This correlation applied to the entire study population (as shown in Figure 2, regression coefficient $r^2 = 0.628$, $p < 0.001$), the survivor group ($r^2 = 0.395$, $p < 0.001$) and the non-survivor group ($r^2 = 0.421$, $p < 0.001$).

Indices for Predicting Hospital Mortality

To assess the predictive values of selected cut-off points for predicting hospital mortality, the sensitivity, specificity, overall correctness of prediction and positive and negative predictive values were all determined. The APACHE III and SOFA scores were found to have the best Youden index and highest overall correctness of prediction (Table 5). Hospital mortality rates differed significantly ($p < 0.001$) below and above cut-offs of 79 APACHE III points, eight SOFA points, 10 Child–Pugh points and 80 mean arterial pressure (in mmHg) (Figure 3).

DISCUSSION

Overall mortality in this investigation was 68.6%, which is in agreement with previous reports that cirrhotic patients admitted to ICU have an extremely poor prognosis (1–3). In critically ill cirrhotic patients, this investigation found that mean arterial pressure, APACHE III and SOFA scores were prognostic significance variables. In fact, Llach J et al. (18) assessed the predictors of survival in cirrhotic patients with ascites and found mean arterial pressure and plasma norepinephrine concentration to be the best predictors of prognosis. Patients with cirrhosis and ascites display a systemic haemodynamic disturbance characterised by arterial hypotension, hypervolemia, high cardiac index and low peripheral resistance (19,20). Several investigations strongly indicate that the cause of these systemic haemodynamic abnormalities is a marked splanchic arteriolar vasodilation (21–24). The increased renin–angiotensin and sympathetic nervous system activity in patients with cirrhosis and ascites is due to a homeostatic response to maintain arterial pressure within or near normal levels.

Notably, a widely used liver-specific severity rating (the Child–Pugh score) is not an independent predictor of mortality. This finding is consistent with reports by other investigators in both ICU and non-ICU settings, suggesting that the Child–Pugh score indicates the severity of underlying liver disease.

| Predictive factors          | Cut-off point* | Youden index | Sensitivity (%) | Specificity (%) | Overall correctness (%) | PPV (%) | NPV (%) |
|-----------------------------|---------------|--------------|----------------|----------------|----------------------------|---------|---------|
| Child–Pugh points           | 10            | 0.52         | 83             | 69             | 76                         | 73      | 80      |
| APACHE III                  | 79            | 0.68         | 93             | 75             | 84                         | 79      | 91      |
| SOFA                        | 8             | 0.68         | 90             | 78             | 84                         | 81      | 89      |
| MAP on ICU admission (mmHg) | 80            | 0.40         | 66             | 74             | 70                         | 72      | 69      |

PPV, positive predictive value; NPV, negative predictive value; APACHE, acute physiology and chronic health evaluation; SOFA, sequential organ failure assessment; MAP, mean arterial pressure; ICU, intensive care unit. *Value giving the best Youden index.
disease, but is not the ideal tool for predicting mortality or resource utilisation in cirrhotic patients with multiple organ failure (3,25–28). The variables included in the APACHE III system have been demonstrated to have prognostic implications for patients with cirrhosis during acute illness. Such variables include components of the Child–Pugh system, for example, bilirubin, albumin and neurologic impairment, as well as factors not directly related to hepatic dysfunction, for example, cardiac, renal, pulmonary parameters, acid–base and fluid–electrolyte status. Additionally, important information related to patient’s age, GI bleeding, sepsis and so on is also considered. Data analysis presented in Table 1 demonstrates significant differences between survivors and non-survivors for key physiological variables not included in the Child–Pugh system. However, the number and categorisation of variables in APACHE III score has increased, enhancing statistical power but reducing simplicity (29–32). In this regard, the use of SOFA is highly economical.

The results of this investigation strongly support that the SOFA score is an excellent tool for assessing the extent of organ dysfunction, not only in patients with sepsis, surgery cases or trauma suffers, and medical cardiovascular patients, but also in critically ill patients with cirrhosis (12,33,34). SOFA score ignores diagnosis, age and co-morbid conditions. SOFA score probably reflects the unique characteristics of the present patient group, whose prognosis could be predicted without considering these factors, namely age and diagnosis. The influence of age on outcome had been demonstrated to decrease with increasing disease severity (35). This could, at least partially, explain why age did not substantially influence the probability of mortality in this work. The analytical results presented here further indicate a significant (p < 0.001) linear correlation between paired SOFA and APACHE III scores for individual patients (Figure 2). Table 5 summarises the predictive accuracy of the SOFA, APACHE III and Child–Pugh systems. The overall predictive accuracy of SOFA and APACHE III was 8% greater than that of the Child–Pugh system.

Despite the encouraging results in our study, several limitations should be noted. First, this investigation involved just one institution, so that the results may not be directly extrapolated to other patient populations. Second, sequential measurement of these scoring systems (for example daily, weekly) may reflect the dynamic aspects of clinical diseases, thus providing superior information on mortality risk. Third, the patient population contained a high proportion of hepatitis B (48%) and hepatoma (33%), meaning its applicability to typical North American and European patients with hepatitis C or alcoholism may be limited (36). Finally, the prognostic instruments were tested on patients already admitted to ICU, rather than being used as a preadmission screening tool, which also may have skewed the measured results.

In conclusion, this investigation demonstrates that the prognosis for cirrhotic patients admitted to ICU is poor. This study also clarified the predictors of mean arterial pressure, APACHE III and SOFA scores that are independently associated with hospital mortality. The data obtained here demonstrate that SOFA and APACHE III had better discriminatory powers than the Child–Pugh system for predicting mortality in critically ill cirrhotic patients. Moreover, the relationship between SOFA and APACHE III scores for patients was linear and correlated significantly in all subgroups.

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