A Comparison of Three Organ Dysfunction Scores: MODS, SOFA and LOD for Predicting ICU Mortality in Critically Ill Patients

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Objective: *To compare the validity of the Multiple Organ Dysfunction Score (MODS), Sequential Organ Failure Assessment (SOFA), and Logistic Organ Dysfunction Score (LOD) for predicting ICU mortality of Thai critically ill patients.*

Material and Method: *A retrospective study was made of prospective data collected between the 1st July 2004 and 31st March 2006 at Songklanagarind Hospital.*

Results: *One thousand seven hundred and eighty two patients were enrolled in the present study. Two hundred and ninety three (16.4%) deaths were recorded in the ICU. The areas under the Receiver Operating Curves (AUC) for the prediction of ICU mortality the results were 0.861 for MODS, 0.879 for SOFA and 0.880 for LOD. The AUC of SOFA and LOD showed a statistical significance higher than the MODS score (p = 0.014 and p = 0.042, respectively). Of all the models, the neurological failure score showed the best correlation with ICU mortality.*

Conclusion: *All three organ dysfunction scores satisfactorily predicted ICU mortality. The LOD and neurological failure had the best correlation with ICU outcome.*

Keywords: *Multiple organ dysfunction, Organ failure, Intensive care unit, Critically ill, Mortality*

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Multiple organ dysfunction is defined as the presence of altered organ function in acutely sick patients. Multiple organ failure is the leading cause of morbidity and mortality in patients admitted to an intensive care unit (ICU)[1-4]. The ICU mortality rate has been correlated with the number of organ failures and the degree of organ dysfunction[5-7]. There are several studies that have shown that the major cause of death is not the underlying disease, but rather the result of progressive multiple organ dysfunction[8-10]. The assessment of organ dysfunction may provide important information for inter-ICU comparison, classifying patients for enrollment in clinical trials and clinical decision- making[11,12].

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The most commonly used organ dysfunction scoring systems are the Multiple Organ Dysfunction Score (MODS), the Sequential Organ Failure Assessment (SOFA), and the Logistic Organ Dysfunction Score (LOD). MODS was based on a literature review by Marshall et al[5] with a score system from 0 to 4 based on six organ failures (cardiovascular, respiratory, hematologic, liver, renal, and neurological systems). The SOFA score was devised by Vincent et al[6] who scored the six organ failures in the same way as the MODS, but with a difference in criteria for each parameter such as the cardiovascular system. The LOD model has been introduced by Le Gall et al[7] and uses a multiple logistic regression analysis on a large database. The six organ failures of the LOD are then defined and the statistical model gives a 0-5 point weighting to each dysfunction.

MODS, SOFA, and LOD organ dysfunction scores have been used in several clinical studies. The reliability of initial and serial of the organ dysfunction scores as an outcome predictor have been demonstrated in critically ill patients[13-19].

There was no study focusing on a comparison of these three organ dysfunction scores undertaken in respect of prediction of ICU mortality in Thailand. The aim of the present study was to evaluate their comparability and discriminative power for predicting ICU mortality in a tertiary mixed medical-surgical ICU of referral university hospital.

Material and Method

Patients and setting

The present study was performed in the ICU of Songklanagarind Hospital, an 800-bed tertiary referral university teaching hospital at the Prince of Songkla University, Songkhla, Thailand. In the present hospital, there are two units in the adult ICU: a ten-bed surgical ICU and a ten-bed mixed medical and coronary care unit.

Data collection

All data were collected concurrently for consecutive ICU admissions, over a 21 month period from July1st 2004 to March 31st 2006. The data for the project were then retrospectively reviewed from prospectively collecting data for the Severity Scoring Systems and Organ Dysfunction Scores. Patients who were excluded from the present study included those who were younger than 15 years of age, suffered burn injuries, had not received attempted cardiac resuscitation, were withdrawn from treatment, died within four hours of admission to the ICU or who stayed in the ICU less than 24 hours. If patients had been admitted more than once to the ICU during the study period, only the first admission was included. Approval for the project was obtained from the faculty Ethics Committee.

The following data were collected as defined according to Knaus et al: basic demographic characteristics, which included sex and age, the presence of any chronic illness, and principal diagnostic category leading to ICU admission[20]. The ICU, hospital length of stay (LOS) and lead time (the interval from hospital admission to ICU admission) were calculated. Patients were followed up until they were discharged from the ICU and hospital in order to register their survival status.

Organ Dysfunction Scores

The poorest physiological values of each organ failure in the 24 hours following ICU admission were used for the authors' calculations as outlined in the original literature[5-7]. For patients who were sedated, a Glasgow Coma Score (GCS) was determined either from their medical records before sedation or through interviewing the physician who ordered the sedation. However, if a variable could not be measured the GCS assumed to be normal. The MODS cardiovascular component was scored as 0 if a central venous pressure line was not performed[5]. Acute Physiology and Chronic Health Evaluation II (APACHE II) and Simplified Acute Physiology Score II (SAPS II) was calculated as described in the original literature reviewed for the present study[20,21].

Statistical analysis

Stata 7 software (Stata Corporation, College Station Tx, USA) was used for statistical analysis. Data are presented as mean $\pm$ SD, when indicated. Student's t test and Wilcoxon's rank sum test were used to compare normally distributed continuous variables and non-parametric data, respectively. Chi-square statistic was used to test for the statistical significance of categorical variables. A p-value less than 0.05 was considered statistically significant. The ability of the models for predicting ICU mortality were determined by examining their discrimination power, which was tested by examining the graph of the area under the Receiver Operating Characteristics curve (AUC), computed by a modification of the Wilcoxon statistic, as described by Hanley and McNeil[22,23]. The agreement of the total scores of the MODS, SOFA, and LOD was evaluated statistically with the Pearson's correlation coefficients.

Results

During the study period, data were collected on 1,782 patients. Overall, 293 patients (16.4%) died in the ICU and 392 patients (22%) died in the hospital before discharge.

The patients' demographic characteristics, type of admission, general diagnostic categories, and chronic illness of the presented patients are shown in Table 1. The severity of patients' illness was assessed by APACHE II and SAPS II, and the organ dysfunction score of the MODS, SOFA, and LOD are shown in Table 2.

The MODS, SOFA, and LOD scores ranged 0-19, 0-20, and 0-22, respectively. The distribution of scores in the presented population is summarized in Fig. 1. Half the patients had a MODS score of 0-4, whereas the figure was 48.1% for the SOFA score and 57.3% for the LOD score. An increase in all the values

Table 1. Demographic and clinical characteristics of 1,782 patients in this study

	All (n = 1,782) N (%)	Survivors (n = 1,489) N (%)	Non-survivors (n = 293) N (%)	p-value
Age (years)	56.0 ± 17.9	55.7 ± 17.9	55.3 ± 19.1	0.106
Male	1,029 (57.7)	570 (56.7)	184 (59.3)	0.622
Type of admission				
Medicine	978 (54.9)	750 (50.4)	228 (77.8)	<0.001
Surgery, scheduled	512 (28.7)	498 (33.4)	14 (4.8)	<0.001
Surgery, unscheduled	292 (16.4)	241 (16.2)	51 (17.4)	0.606
Categories of diseases				
Non-operative				
Respiratory disease	100 (5.6)	94 (6.3)	6 (2)	0.004
Coronary artery disease	252 (14.1)	238 (16)	14 (4.7)	<0.001
Others Cardiovascular	225 (12.6)	151 (10.1)	74 (25.2)	<0.001
Sepsis	295 (16.6)	178 (12)	117 (39.9)	<0.001
Neurologic disease	31 (1.7)	29 (2)	2 (0.6)	0.13
Gastrointestinal disease	43 (2.4)	28 (1.9)	15 (5.1)	0.001
Other	32 (1.9)	32 (2.1)	1 (0.3)	0.008
Post-operative disease				
Post-CABG	80 (4.3)	76 (5.1	4 (1.4)	0.005
Post cardiac surgery	213 (11.9)	199 (13.4)	14 (4.8)	<0.001
Brain and spinal cord	160 (9)	147 (9.9)	13 (4.4)	0.003
Gastrointestinal	116 (6.5)	107 (7.2)	9 (3.1)	0.121
Other	235 (13.2)	210 (14)	25 (8.5)	0.001
Chronic illness				
Liver cirrhosis	26 (1.46)	16 (1.1)	10 (3.4)	0.002
Severe COPD	15 (0.84)	10 (0.7)	5 (1.7)	0.076
Chronic renal failure	31 (1.7)	21 (1.4)	10 (3.4)	0.017
Heart failure class IV	5 (0.3)	0 (0)	5 (1.7)	<0.001
Hematologic malignancy	67 (3.8)	35 (2.4)	32 (10.9)	<0.001
Metastasis carcinoma	46 (2.6)	28 (1.9)	18 (6.1)	<0.001
Immunocompromised	43 (2.4)	25 (1.7)	18 (6.1)	<0.001
AIDS	21 (1.2)	17 (1.1)	4 (1.4)	0.746
None of the above	1,528 (85.8)	1,337 (89.8)	191 (65.2)	<0.001

CABG, coronary artery bypass graft; COPD, chronic obstructive pulmonary disease; AIDS, acquired immune deficiency syndrome

Table 2. Severity scores, organ dysfunction scores and length of stay of patients in this study

	All (n = 1,782)	Survivors (n = 1,489)	Non-survivors (n = 293)	p-value
APACHE II	17.9 ± 9.5	15.3 ± 7.1	31.1 ± 9.4	<0.001
SAPS II	39.2 ± 20	34.0 ± 15.0	66.0 ± 20.8	<0.001
MODS	5.4 ± 4	4.4 ± 3.3	10.1 ± 3.9	<0.001
SOFA	5.2 ± 4.1	4.5 ± 3.4	10.7 ± 3.9	<0.001
LOD	4.8 ± 3.9	3.8 ± 2.8	10.2 ± 4. 5	<0.001
ICU LOS (day)*	2 (1-5)	2 (1-4)	2 (1-6)	0.955
Hospital LOS (day)*	15.5 (8-29)	17 (10-31)	5 (2-15)	<0.001
Lead time (day)*	1 (0-5)	1 (0-5)	0 (0-4)	0.025

* Median (interquartile range)

APACHE II, Acute Physiology and Chronic Health Evaluation II; SAPS II, Simplified Acute Physiology Score II; MODS, Multiple Organ Dysfunction Score; SOFA, Sequential Organ Failure Assessment; LOD, Logistic Organ Dysfunction Score; LOS, length of stay

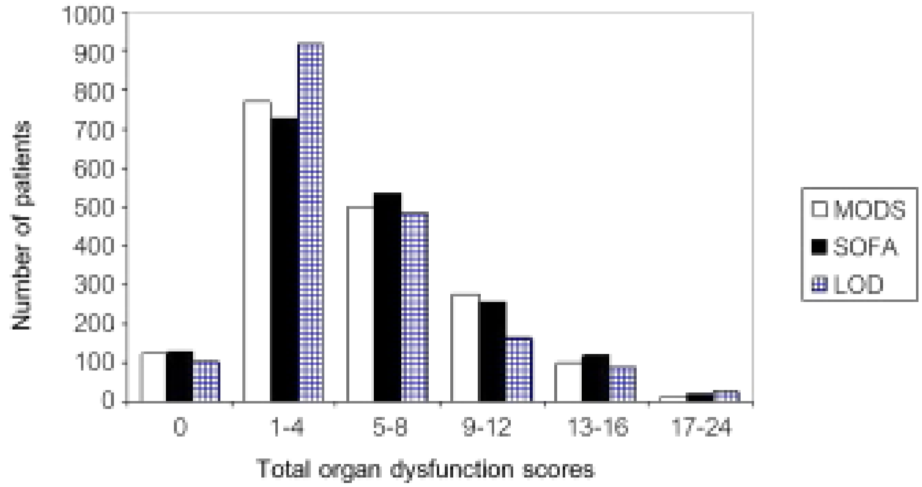

Fig. 1 Distribution of the three organ dysfunction scores for the entire study population

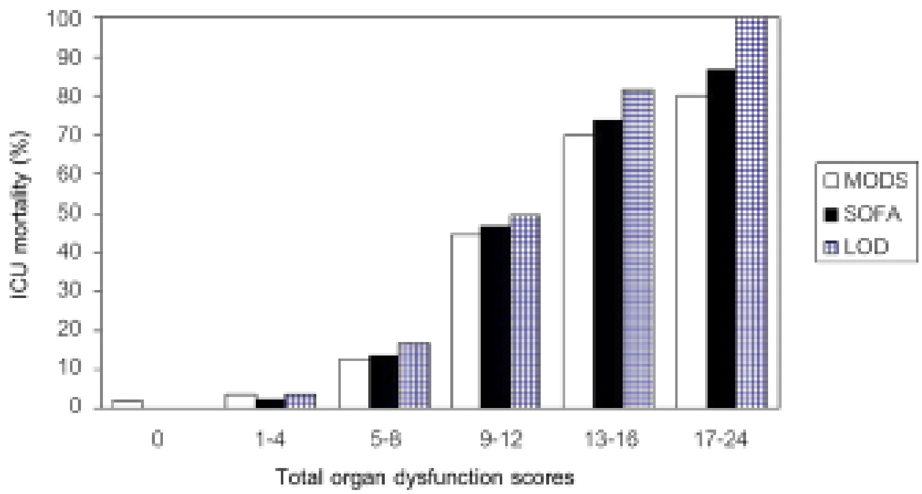

Fig. 2 Correlation of the three organ dysfunction scores with ICU mortality

for the organ dysfunction score models was strongly associated with ICU mortality (Fig. 2). No deaths occurred in patients with SOFA and LOD scores of 0; however, the patients with MODS score of 0 did show an ICU mortality of 1.6%. The ICU mortality rate was 100% for the patients with LOD scores above 17 and 80% and 86.7% for those patients with MODS and SOFA scores between 16-19 and 16-20, respectively.

The AUC of the MODS, SOFA, and LOD with an individual organ dysfunction score are given in Table 3. The discrimination of all the models as a predictor of ICU death was good with the LOD score showing the best results. The neurological score of all models are a good predictor for ICU mortality but the hepatological and hematological scores were found to be less closely associated with ICU mortality. The AUC of APACHE II and SAPS II scores are better than all the organ dysfunction scores (AUC = 0.913 and 0.895, respectively).

The AUC of SOFA and LOD showed a statistical significance higher than the MODS score (p = 0.014 and p = 0.042, respectively). However, there are

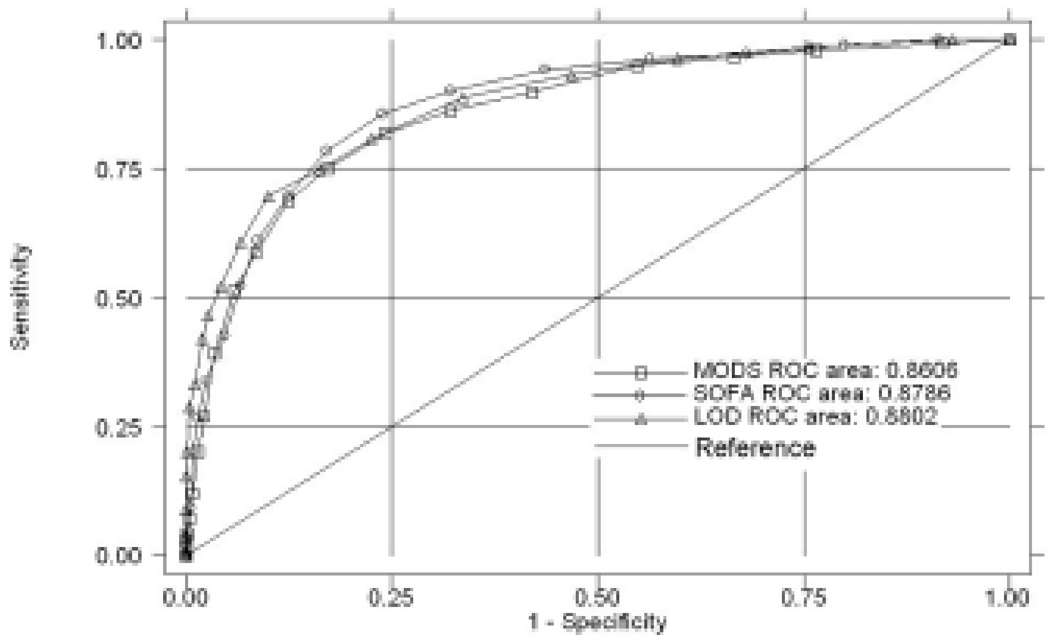

Fig. 3 Comparison of the areas under the receiver operating characteristics curves for the prediction of ICU mortality

Table 3. Areas under the receiver operating characteristics curve (AUC) and 95% confidence interval (CI) for each organ dysfunction scores and subscores as predictors of ICU mortality

Scores	AUC	95% CI
MODS total score	0.861	0.837-0.884
MODS cardiovascular score	0.726	0.692-0.759
MODS pulmonary score	0.710	0.675-0.745
MODS renal score	0.659	0.624-0.693
MODS hepatological score	0.539	0.501-0.576
MODS neurological score	0.839	0.811-0.867
MODS hematological score	0.632	0.594-0.670
SOFA total score	0.879	0.858-0.899
SOFA cardiovascular score	0.756	0.724-0.788
SOFA pulmonary score	0.725	0.691-0.758
SOFA renal score	0.678	0.643-0.712
SOFA hepatological score	0.539	0.502-0.577
SOFA neurological score	0.840	0.812-0.868
SOFA hematological score	0.623	0.585-0.662
LOD total score	0.880	0.858-0.902
LOD cardiovascular score	0.772	0.742-0.802
LOD pulmonary score	0.704	0.672-0.737
LOD renal score	0.727	0.694-0.760
LOD hepatological score	0.563	0.526-0.600
LOD neurological score	0.822	0.791-0.852
LOD hematological score	0.590	0.551-0.628

no differences between the AUC of the SOFA and LOD scores ($p = 0.843$) (Fig. 3).

Pearson's correlation coefficients for the total scores were 0.905 for MODS and SOFA ($p < 0.001$), 0.798 for MODS and LOD ($p < 0.001$) and 0.83 for SOFA and LOD ($p < 0.001$).

Discussion

The assessment of morbidity during ICU stay may provide important information about a patients' illness, their response to treatment and describe the patient population in clinical trials better than the current severity scoring systems. The MODS, SOFA, and LOD are the popular models in common use throughout the world for organ dysfunction assessment. These scores were designed using different methods as previously discussed above. The MODS score records the worst value of the whole ICU stay for each dysfunction but the SOFA and LOD scores use the worst value for each day[5-7]. It is important to note the SOFA score was specifically designed to describe morbidity and it includes several therapeutic variables such as inotropic therapy. The LOD score was designed as a tool for evaluation the probability of mortality based on organ dysfunction on the day of ICU admission, not for measuring the severity of each organ dysfunction continuously[7]. Nevertheless, the three organ dysfunction scores have many similarities that include the same six organ systems, range of scores and proven power in predictions for ICU mortality in critically ill patients[13-15,19].

In the present study, the authors have evaluated the ability of the MODS, SOFA, and LOD scores to predict ICU mortality in a case-mix of Thai adult ICU patients. The present results showed that the MODS, SOFA, and LOD correlated well with the outcome in terms of predicting ICU mortality. A model's discrimination (the ability of the model to distinguish patients who die from those who survive) was assessed by numerically examining the AUC. An AUC of one is a perfect discrimination and an AUC of 0.5 is a random chance. The model has good discrimination when AUC > 0.8 and excellent for AUC > 0.9. All the models gave a good discrimination; the LOD had the best AUC. The AUC in the present study were similar or better than other reports have suggested such as Bota et al[15] who reported results of initial MODS and SOFA scores of 0.856 and 0.872 and Timsit et al[18] who found 0.720 and 0.726 for day one of their SOFA and LOD scores, while Pettuila et al[17] found scores of 0.695, 0.776 and 0.805 for day-1 of the MODS, SOFA and LOD respectively and Ferreira et al reported 0.79 for the initial SOFA score[19]. The AUC for the original MODS and LOD were 0.928 and 0.843, respectively[5,7].

The sub-score for the neurological failure gave the best correlation with ICU mortality through cardiovascular and pulmonary failure. This, however, is different from a previous report that showed that cardiovascular score had the best AUC, whereas the neurological score was the worst AUC[13]. The reason for this discrepancy is unclear, but it may relate to differences of data definition and collection and the use of case-mix patients.

The AUC for all the organ dysfunction models has less than severity scoring systems because all of these scores were developed primarily to assess the severity of organ failure rather than predict mortality, as with the APACHE II and SAPS II systems. Nevertheless, all these organ dysfunction scores have been demonstrated to predict ICU mortality, with the best AUC being: AUC > 0.8.

Organ dysfunction failure is a dynamic process and the degree of dysfunction may vary with time and treatment[24]. Serial or repetitive assessment of organ dysfunction scores allow for a more effective representation of an outcome prediction than does a single measurement[13-19]. Several papers have reported that maximum, mean or delta scores demonstrated a better correlation with mortality than did an initial or first 24 hrs dysfunction score each organ[14,15,17,19].

The authors used the ICU mortality statistic as the primary outcome for evaluating the validity of organ dysfunction scores for several reasons. Firstly, most of the patients who die in the hospital from multiple organ dysfunction failure do so in the ICU. Second, the most common cause of death in the ICU is multiple organ failure[1-5]. Finally, hospital mortality is influenced by many factors that occur from discharge from the ICU. Our ICU mortality rate (16.9%) is lower than those previously reported (18.5-22.7%)[6,15,17]. This discrepancy may be due to a difference: in case-mix, in severity of patient's illness, in ICU performance, and quality of care.

The present study does have some limitations. First, through studying only a single centre it places limitations on the case-mix and quality of ICU care. Secondly, evaluation of a single assessment of organ dysfunction scores after the first 24 hrs of ICU admission may not be so accurate. In Thai ICUs, it would be better to make serial measurements for the evaluation of organ dysfunction scores for predicting the outcome in critically ill patients.

In conclusion, the first 24 hrs score of the MODS, SOFA, and LOD are reliable for predicting ICU mortality in critically ill, Thai patients. The LOD score and neurological score of all models are the best discrimination outcome.

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References

1. Tran DD, Cuesta MA, van Leeuwen PA, Nauta JJ, Wesdorp RI. Risk factors for multiple organ system failure and death in critically injured patients. Surgery 1993; 114: 21-30.
2. Zimmerman JE, Knaus WA, Wagner DP, Sun X, Hakim RB, Nystrom PO. A comparison of risks and outcomes for patients with organ system failure: 1982-1990. Crit Care Med 1996; 24: 1633-41.
3. Baue AE. Multiple organ failure, multiple organ dysfunction syndrome, and systemic inflammatory response syndrome. Why no magic bullets? Arch Surg 1997; 132: 703-7.
4. Deitch EA. Multiple organ failure. Pathophysiology and potential future therapy. Ann Surg 1992;

216: 117-34.
5. Marshall JC, Cook DJ, Christou NV, Bernard GR, Sprung CL, Sibbald WJ. Multiple organ dysfunction score: a reliable descriptor of a complex clinical outcome. Crit Care Med 1995; 23: 1638-52.
6. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonca A, Bruining H, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine. Intensive Care Med 1996; 22: 707-10.
7. Le Gall JR, Klar J, Lemeshow S, Saulnier F, Alberti C, Artigas A, et al. The Logistic Organ Dysfunction system. A new way to assess organ dysfunction in the intensive care unit. ICU Scoring Group. JAMA 1996; 276: 802-10.
8. TenHoor T, Mannino DM, Moss M. Risk factors for ARDS in the United States: analysis of the 1993 National Mortality Followback Study. Chest 2001; 119: 1179-84.
9. Johnston JA. Determinants of mortality in patients with severe sepsis. Med Decis Making 2005; 25: 374-86.
10. Micek ST, Isakow W, Shannon W, Kollef MH. Predictors of hospital mortality for patients with severe sepsis treated with Drotrecogin alfa (activated). Pharmacotherapy 2005; 25: 26-34.
11. Ehrmann S, Mercier E, Bertrand P, Dequin PF. The logistic organ dysfunction score as a tool for making ethical decisions. Can J Anaesth 2006; 53: 518-23.
12. Cabre L, Mancebo J, Solsona JF, Saura P, Gich I, Blanch L, et al. Multicenter study of the multiple organ dysfunction syndrome in intensive care units: the usefulness of Sequential Organ Failure Assessment scores in decision making. Intensive Care Med 2005; 31: 927-33.
13. Buckley TA, Gomersall CD, Ramsay SJ. Validation of the multiple organ dysfunction (MOD) score in critically ill medical and surgical patients. Intensive Care Med 2003; 29: 2216-22.
14. Moreno R, Vincent JL, Matos R, Mendonca A, Cantraine F, Thijs L, et al. The use of maximum SOFA score to quantify organ dysfunction/failure in intensive care. Results of a prospective, multicentre study. Working Group on Sepsis related Problems of the ESICM. Intensive Care Med 1999; 25: 686-96.
15. Peres BD, Melot C, Lopes FF, Nguyen BV, Vincent JL. The Multiple Organ Dysfunction Score (MODS) versus the Sequential Organ Failure Assessment (SOFA) score in outcome prediction. Intensive Care Med 2002; 28: 1619-24.
16. Pettila V. Sequential assessment of multiple organ dysfunction as a predictor of outcome. JAMA 2002; 287: 713-4.
17. Pettila V, Pettila M, Sarna S, Voutilainen P, Takkunen O. Comparison of multiple organ dysfunction scores in the prediction of hospital mortality in the critically ill. Crit Care Med 2002; 30: 1705-11.
18. Timsit JF, Fosse JP, Troche G, De Lassence A, Alberti C, Garrouste-Org, et al. Calibration and discrimination by daily Logistic Organ Dysfunction scoring comparatively with daily Sequential Organ Failure Assessment scoring for predicting hospital mortality in critically ill patients. Crit Care Med 2002; 30: 2003-13.
19. Ferreira FL, Bota DP, Bross A, Melot C, Vincent JL. Serial evaluation of the SOFA score to predict outcome in critically ill patients. JAMA 2001; 286: 1754-8.
20. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med 1985; 13: 818-29.
21. Le Gall JR, Lemeshow S, Saulnier F. A new Simplified Acute Physiology Score (SAPS II) based on a European/North American multicenter study. JAMA 1993; 270: 2957-63.
22. Hanley JA. Receiver operating characteristic (ROC) methodology: the state of the art. Crit Rev Diagn Imaging 1989; 29: 307-35.
23. Hanley JA, McNeil BJ. A method of comparing the areas under receiver operating characteristic curves derived from the same cases. Radiology 1983; 148: 839-43.
24. Le Gall JR. The use of severity scores in the intensive care unit. Intensive Care Med 2005; 31: 1618-23.

เปรียบเทียบระดับคะแนนอวัยวะล้มเหลว MODS, SOFA และ LOD ในการทำนายอัตราตายในหออภิบาลของผู้ป่วยหนัก

บดินทร์ ขวัญนิมิตร

วัตถุประสงค์*:* *เพื่อเปรียบเทียบการทำนายอัตราตายในหออภิบาลของผู้ป่วยหนักโดยระบบคะแนนอวัยวะล้มเหลว Multiple Organ Dysfunction Score (MODS), Sequential Organ Failure Assessment (SOFA) และ Logistic Organ Dysfunction Score (LOD) ของผู้ป่วยหนักในประเทศไทย*

วัสดุและวิธีการ*:* *ทบทวนข้อมูลย้อนหลังจากการเก็บข้อมูลแบบต่อเนื่องของผู้ป่วยที่เข้ารับการรักษาในหออภิบาลโรงพยาบาลสงขลานครินทร์ในช่วง 1 กรกฎาคม พ.ศ. 2547 ถึง 31 มีนาคม พ.ศ. 2549*

ผลการศึกษา*:* *ผู้ป่วยทั้งหมด 1,782 ราย เสียชีวิตในหออภิบาล 293 ราย คิดเป็นร้อยละ 16.4 พื้นที่ใต้ Receiver Operating Curve ของระบบ MODS เท่ากับ 0.861 ระบบ SOFA เท่ากับ 0.879 และ ระบบ LOD เท่ากับ 0.880 ในการทำนายอัตราตายในหออภิบาล พื้นที่ใต้ receiver operating curve ของระบบ LOD และ SOFA สูงกว่าระบบ MODS อย่างมีนัยสำคัญ (p = 0.014 และ p = 0.042 ตามลำดับ) ระบบประสาททำงานล้มเหลวของทั้งสามระบบมีความสัมพันธ์กับอัตราตายในหออภิบาลมากกว่าระบบอื่น ๆ*

สรุป*:* *ระบบคะแนนอวัยวะล้มเหลวทั้งสามระบบสามารถทำนายอัตราตายในหออภิบาลได้ดี ระบบคะแนน LOD และการทำงานล้มเหลวของระบบประสาทมีความสัมพันธ์กับอัตราตายในหออภิบาลมากที่สุด*