Intensive Care Med (2002) 28:1619–1624
DOI 10.1007/s00134-002-1491-3

ORIGINAL

Daliana Peres Bota
Christian Melot
Flavio Lopes Ferreira
Vinh Nguyen Ba
Jean-Louis Vincent

The Multiple Organ Dysfunction Score (MODS) versus the Sequential Organ Failure Assessment (SOFA) score in outcome prediction

Received: 20 November 2001
Accepted: 6 August 2002
Published online: 6 September 2002

D. Peres Bota · C. Melot · F. Lopes Ferreira
V. Nuygen Ba · J.-L. Vincent (✉)
Department of Intensive Care,
Erasme University Hospital,
Route de Lennik 808, 1070 Brussels,
Belgium
e-mail: jlvincen@ulb.ac.be
Tel.: +32-2-5553380
Fax: +32-2-5554555

Abstract *Objective:* To compare outcome prediction using the Multiple Organ Dysfunction Score (MODS) and the Sequential Organ Failure Assessment (SOFA), two of the systems most commonly used to evaluate organ dysfunction in the intensive care unit (ICU). *Design:* Prospective, observational study. *Setting:* Thirty-one-bed, university hospital ICU. *Patients and participants:* Nine hundred forty-nine ICU patients. *Measurements and results:* The MODS and the SOFA score were calculated on admission and every 48 h until ICU discharge. The Acute Physiology and Chronic Health Evaluation (APACHE) II score was calculated on admission. Areas under receiver operating characteristic (AUROC) curves were used to compare initial, 48 h, 96 h, maximum and final scores. Of the 949 patients, 277 died (mortality rate 29.1%). Shock was observed in 329 patients (mortality rate 55.3%). There were no significant differences between the two scores in terms of mortality prediction. Outcome prediction of the APACHE II score was similar to the initial MODS and SOFA score in all patients, and slightly worse in patients with shock. Using the scores' cardiovascular components (CV), outcome prediction was better for the SOFA score at all time intervals (initial AUROC SOFA CV 0.750 vs MODS CV 0.694, $p<0.01$; 48 h AUROC SOFA CV 0.732 vs MODS CV 0.675, $p<0.01$; and final AUROC SOFA CV 0.781 vs MODS CV 0.674, $p<0.01$). The same tendency was observed in patients with shock. There were no significant differences in outcome prediction for the other five organ systems. *Conclusions:* MODS and SOFA are reliable outcome predictors. Cardiovascular dysfunction is better related to outcome with the SOFA score than with the MODS.

Keywords Mortality · Cardiovascular system · Scoring systems · Organ dysfunction

Introduction

Multiple organ failure (MOF) is the leading cause of morbidity and mortality in patients admitted to the intensive care unit (ICU), and can be characterized by different degrees and combinations of organ dysfunction or failure. Studies of patients with MOF have been hampered by the lack of objective criteria for defining the clinical syndrome, although the ICU mortality rate has been correlated with the number of failing organs and with the degree of organ dysfunction [1, 2]. Quantification of organ dysfunction/failure is important for several reasons, including: to facilitate the description of severity of illness in different ICUs and different groups of patients, enabling comparison over time or among groups; for use in clinical trials, to classify patients for enrolment, to compare treatment groups and to evaluate the effects of experimental treatments and procedures on morbidity [3].

Table 1 The Multiple Organ Dysfunction Score (MODS) [5] (*PAR* pressure adjusted heart rate calculated as the product of the heart rate multiplied by the ratio of the right atrial pressure to the mean arterial pressure)

Organ system	Score				
	0	1	2	3	4
Respiratory: PO_2/FIO_2 ratio (mmHg)	>300	226–300	151–225	76–150	≤75
Renal: serum creatinine (mg/dl)	≤1.1	1.2–2.2	2.3–3.9	4–5.6	≥5.7
Hepatic: serum bilirubin (mg/dl)	≤1.2	1.3–3.5	3.6–7	7–14	>14
Cardiovascular: PAR	≤10	10.1–15	15.1–20	20.1–30	>30
Hematologic: platelet count ($\times 10^3/mm^3$)	>120	81–120	51–80	21–50	≤20
Neurologic: Glasgow Coma Score	15	13–14	10–12	7–9	≤6

Table 2 The Sequential Organ Failure Assessment (SOFA) [4]

	0	1	2	3	4
Respiratory: PaO_2/FIO_2 (mmHg)	>400	≤400	≤300	≤200[b]	≤100[b]
Renal: creatinine (mg/dl)or urine output	<1.2	1.2–1.9	2.0–3.4	3.5–4.9 or <500 ml/d	≥5.0 or <200 ml/d
Hepatic: bilirubin (mg/dl)	<1.2	1.2–1.9	2.0–5.9	6.0–11.9	≥12.0
Cardiovascular: hypotension	No hypotension	MAP <70 mmHg	Dopamine ≤5 or dobutamine (any dose)[a]	Dopamine >5 or epinephrine ≤0.1 or norepi- nephrine ≤0.1[a]	Dopamine >15 or epinephrine >0.1 or norepi nephrine >0.1[a]
Hematologic: platelet count ($\times 10^3/mm^3$)	>150	≤150	≤100	≤50	≤20
Neurologic: Glasgow Coma Score	15	13–14	10–12	6–9	<6

[a] Adrenergic agents administered for at least 1 h (doses given are in µg/kg/min)
[b] With ventilatory support

Several organ dysfunction scores have been developed for use in the critically ill [4, 5, 6, 7, 8]. The most commonly used organ dysfunction scoring systems are the multiple organ dysfunction score (MODS) (Table 1) [5], and the sequential organ failure assessment (SOFA) (Table 2) [4]. The main difference between the MODS and the SOFA is the evaluation of cardiovascular function. In the MODS, cardiovascular assessment is based on the so-called "pressure-adjusted heart rate" (PAR), defined as the product of the heart rate (HR) multiplied by the ratio of the right atrial pressure (RAP) to the mean arterial pressure (MAP). Although relatively simple, PAR still requires computation. The SOFA score uses the MAP and therapeutic interventions with vasopressors to quantify cardiovascular function. However, being therapy-dependent, this method carries the risk of some variability depending on physicians' drug preferences and local protocol. Although the MODS and SOFA were developed primarily to describe organ dysfunction, several studies have demonstrated the relationship between organ failure and mortality [9, 10, 11, 12].

The aim of our study was to compare the accuracy of the two scores in terms of outcome prediction in a general ICU population and in patients with circulatory shock, with particular emphasis on the cardiovascular score.

Patients and methods

Demographic, laboratory and clinical data were collected for all patients admitted during three distinct periods: April–July 1999, October–November 1999 and July–September 2000. The Acute Physiology and Chronic Health Evaluation (APACHE) II score was calculated using the worst values for the first 24 h following ICU admission. The MODS and the SOFA score were calculated on admission and every 48 h until discharge. To calculate the MODS, we recorded the first morning values as recommended by Marshall et al. [5]. For the SOFA we recorded the worst value over 24 h, as recommended [9]. For a single missing value, a replacement was computed as the mean of the variables that preceded and followed the missing one. The MODS cardiovascular component was scored as 0 if a central venous pressure line was not in situ. The pre-sedation Glasgow Coma Score was used to evaluate the neurologic status in patients under sedation [13].

The two scores were compared at four time intervals: initial (first 24 h), at 48 h, 96 h and final (discharge or death). The maximum score was also recorded as the highest score obtained for a 24h period. Scores from patients with shock, defined according to the ACCP-SCCM consensus conference as hypotension or the need for vasopressors/inotropes to maintain blood pressure despite adequate fluid resuscitation and the presence of perfusion abnormalities [14], were analyzed separately. The results are presented as means ± standard deviation. Areas under receiver operating characteristic curves (AUROC) were calculated in order to analyze the discrimination of the scores using mortality as an independent variable. All statistical tests were two-tailed and a p value less than 0.05 was considered as significant.

Results

Of the 949 patients included in the study, 439 were admitted for at least 48 h and 236 for at least 96 h. Two hundred seventy-seven patients (29.1%) died. Shock was present in 329 patients [septic (118), cardiogenic (93), hypovolemic (67), hemorrhagic (40) and anaphylactic (11)], of whom 182 (55.3%) died. Forty-two patients developed shock during the ICU stay. The characteristics of the patients are presented in Table 3.

There was no significant difference between the MODS and the SOFA in terms of mortality prediction (Tables 4 and 5) and, as expected, the MODS and the SOFA were significantly higher in the non-survivors than in the survivors (Table 6). In 90% of cases, the maximum scores for both scoring systems were recorded on the same day. For both scores the best outcome predictor was the maximum value, followed by the final value (Table 4). The maximum cardiovascular SOFA was a better predictor of mortality than the maximum cardiovascular MODS in the whole population and in the subgroup of patients with shock (Tables 4 and 5). There were no differences between the two scores for the other

Table 3 Main characteristics of the patients

	Study population (*n*=949)	Patients with shock (*n*=329)
Age (years)[a]	58±17	58±16
Gender M/F	588/361	201/128
Type of admission		
Medical/surgical	518/431	177/152
Length of stay (days)[b]	2 (1–29)	4 (1–29)
APACHE II score[a]	14.4±7.7	18.2±8.5
Mortality	277 (29.1%)	182 (55.3%)

[a] Values expressed as means ± SD
[b] Value expressed as median (range)

Table 4 Comparison between the total Multiple Organ Dysfunction Score (*MODS*) and Sequential Organ Failure Assessment (*SOFA*) score, and between their cardiovascular (*CV*) components (*AUROC* area under receiver operator characteristic curve)

Time	MODS[a]	MODS (AUROC)	SOFA[a]	SOFA (AUROC)	*p* value
Initial	4.3±3.5	0.856	5.2±3.9	0.872	NS
48 h	5.5±4.2	0.834	6.5±4.8	0.844	NS
96 h	5.6±4.4	0.861	7.0±5.0	0.847	NS
Final	4.1±4.0	0.869	5.1±4.5	0.897	NS
Maximum	5.6±4.0	0.900	7.2±4.3	0.898	NS
	MODS CV[a]	MODS CV (AUROC)	SOFA CV[a]	SOFA CV (AUROC)	*p* value
Initial	1.1±1.1	0.694	1.0±1.3	0.750	0.0002
48 h	1.4±1.3	0.675	1.2±1.5	0.732	0.0209
96 h	1.1±1.1	0.690	1.6±1.6	0.739	NS
Final	1.5±1.3	0.674	1.3±1.5	0.781	0.0001
Maximum	1.6±1.1	0.750	1.7±1.3	0.821	0.0001

[a] Values expressed as means ± SD

Table 5 Comparison between the total Multiple Organ Dysfunction Score (*MODS*) and Sequential Organ Failure Assessment (*SOFA*) score, and between their cardiovascular (*CV*) components in the subgroup of patients with shock (*AUROC* area under receiver operator characteristic curve)

Time	MODS[a]	MODS (AUROC)	SOFA[a]	SOFA (AUROC)	*p* value
Initial	6.8±3.8	>0.852	8.4±4.1	0.869	NS
48 h	7.7±4.5	0.868	9.2±5.0	0.861	NS
96 h	7.3±5.0	0.923	9.2±5.4	0.910	NS
Final	6.9±4.9	0.888	8.3±5.4	0.898	NS
Maximum	8.2±4.4	0.908	9.7±4.8	0.906	NS
	MODS CV[a]	MODS CV (AUROC)	SOFA CV[a]	SOFA CV (AUROC)	*p* value
Initial	1.9±1.0	0.557	2.5±1.1	0.694	NS
48 h	2.0±1.3	0.709	2.6±1.0	0.768	NS
96 h	1.4±1.2	0.749	2.5±1.5	0.833	0.05
Final	2.5±1.1	0.662	3.1±0.9	0.846	NS
Maximum	2.6±1.5	0.640	3.2±1.1	0.806	0.01

[a] Values expressed as means ± SD

Table 6 Multiple Organ Dysfunction Score (*MODS*) and Sequential Organ Failure Assessment (*SOFA*) scores in survivors and non-survivors. Values are expressed as means ± SD, and *p* is less than 0.01 for all comparisons between survivors and non-survivors

Time	MODS		SOFA	
	Survivors	Non-survivors	Survivors	Non-survivors
Initial	2.9±2.2	7.7±3.7	3.5±2.4	9.1±4.1
48 h	3.3±2.5	8.5±4.1	4.0±2.8	10.0±4.7
96 h	3.1±2.3	8.5±4.4	4.2±2.8	10.1±15.0
Final	2.5±1.9	8.2±4.4	3.1±1.9	9.8±4.9
Maximum	3.4±2.4	9.3±3.9	4.3±2.6	10.7±4.6
Patients with shock				
Initial	4.3±2.3	8.8±3.6	5.5±2.3	10.7±3.9
48 h	4.5±3.1	10.1±3.8	5.7±3.5	11.9±4.3
96 h	3.2±2.4	10.5±4.1	4.9±2.8	12.5±4.5
Final	3.2±2.6	9.8±4.4	4.2±2.5	11.6±4.8
Maximum	4.8±2.6	10.9±3.7	6.1±2.8	12.7±4.1

five organ systems at any time during the ICU stay (data not shown). For the first 24 h, in the whole study group, the AUROC for the APACHE II score (0.880) was only slightly better than that for the SOFA (0.872) and the MODS (0.856). In the patients with shock, the MODS and the SOFA score were slightly better mortality predictors than the APACHE II score (AUROC 0.852 and 0.869 vs 0.825).

Discussion

Scoring systems can be useful to describe patient populations for ICU management, clinical trials and quality control. Traditional outcome prediction relies on measurements taken during the first 24 h of ICU stay and includes systems such as APACHE II [15] and III [16], Simplified Acute Physiology Score (SAPS) II [17] and Mortality Probability Models (MPM) II [18].

Although the ultimate outcome measure for any patient is survival (or mortality), death is not the only relevant measure of the success or failure of ICU care. The assessment of morbidity during an ICU stay may provide important information on a patient's illness and response to treatment and, in addition, may better describe patient populations for enrolment in clinical trials, for inter-ICU comparison and for cost-effectiveness studies. Techniques able to evaluate organ dysfunction serially in individual patients have therefore been developed. The MODS was based on a literature review of all studies related to MOF published between 1969 and 1993, to determine which characteristics had been used to define organ failure [5]. The chosen variables were then assessed for their ability to predict ICU mortality in a population of 336 surgical ICU patients, which represented the developmental set, and the validation was performed on a series of 356 patients.

The SOFA score was developed during a consensus conference organized by the European Society of Intensive Care and Emergency Medicine [4]. Originally termed the "sepsis-related" organ failure assessment, it can be applied equally to all ICU patients. Initial validation was performed on a heterogeneous group of 1,449 critically ill patients [9]. The MODS and the SOFA allow the calculation of a summary value for the degree of dysfunction for six organs (respiratory, hematologic, liver, cardiovascular, central nervous system and renal). Four levels of dysfunction are identified for each of the organ systems for both the MODS and the SOFA score.

The logistic organ dysfunction system (LODS) score was developed in 1996 [6] using a multiple logistic regression technique on a large database of 13,152 admissions to 137 ICUs in 12 countries. However, the LODS combines the level of dysfunction of all organs in a single score and was designed to be calculated only for the first 24 h. It has not been validated for repeated use during the ICU stay and we therefore chose to limit our comparison to the MODS and the SOFA.

The MODS [19, 20, 21, 22, 23, 24, 25, 26] and the SOFA [27, 28, 29, 30, 31, 32, 33, 34] have been used in many clinical studies. The reliability of the MODS as an outcome predictor has been demonstrated [10, 25] and the correlation between a high degree of organ failure as assessed by the SOFA score and mortality is well established [9, 11, 12, 35, 36]. Our results show that the MODS and the SOFA score correlate well with outcome in terms of mortality prediction and with the APACHE II score. Interestingly, in the subgroup of patients with shock, the MODS and the SOFA score had better predictive values for mortality than the APACHE II score. When directly compared, there were no differences between the MODS and the SOFA score in outcome prediction.

The main difference between the two systems is the computation of the cardiovascular score. In the MODS system, the PAR is used, while the SOFA score uses the mean arterial pressure and takes into account the use of vasopressors. Both systems have their limitations. An ideal variable used to build an organ failure score should be treatment-independent, which is why Marshall and colleagues chose to develop a more complex variable. Although not very complicated, the variable requires a computerized system, which limits the immediate bedside availability of the score. In addition, two patients may have the same PAR, but one may be receiving high doses of vasopressor agents, while the other is hemodynamically stable; these two patients will clearly not have the same degree of cardiovascular dysfunction. Thus although, ideally, a variable describing organ dysfunction/failure should be independent of therapeutic interventions, which can indeed be influenced by individual user preference and local protocol, our study shows that the SOFA therapy-related cardiovascular score was a better outcome predictor than the cardiovascular MODS. The same trend was observed in the subgroup of patients with shock.

Although there are some other differences between the two scores, for example, adding the daily diuresis to serum creatinine for the SOFA renal score and taking into account ventilatory support for the respiratory SOFA score, as well as slight variations in the cut-off ranges employed, there were no significant differences between the MODS and the SOFA for any organ system except the cardiovascular system.

In conclusion, the MODS and the SOFA score are reliable outcome predictors in critically ill patients, performing at least as well as the APACHE II score. Moreover, cardiac scores alone are good outcome predictors. The use of therapy-related variables to describe cardiovascular function may be better than variables derived in a more complicated manner, such as that used in the MODS.

References

1. Goris RJ, Te Boekhorst TP, Nuytinck JK, Gimbrere JS (1985) Multiple-organ failure. Generalized autodestructive inflammation? Arch Surg 120:1109–1115
2. Marshall JC, Christou NV, Horn R, Meakins JL (1988) The microbiology of multiple organ failure. Arch Surg 123:309–315
3. Vincent JL, Ferreira F, Moreno R (2000) Scoring systems for assessing organ dysfunction and survival. Crit Care Clin 16:353–366
4. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, Reinhart CK, Suter PM, Thijs LG (1996) The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. Intensive Care Med 22:707–710
5. Marshall JC, Cook DJ, Christou NV, Bernard GR, Sprung CL, Sibbald WJ (1995) Multiple organ dysfunction score: A reliable descriptor of a complex clinical outcome. Crit Care Med 23:1638–1652
6. Le Gall JR, Klar J, Lemeshow S, Saulnier F, Alberti C, Artigas A, Teres D, ICU Scoring Group (1996) The logistic organ dysfunction system: a new way to assess organ dysfunction in the intensive care unit. JAMA 276:802–810
7. Bernard GR, Doig BG, Hudson G, Lemeshow S, Marshall S, Russell JC, Sibbald J, Sprung CL, Vincent JL, Wheeler AP (1995) Quantification of organ failure for clinical trials and clinical practice (abstract). Am J Respir Crit Care Med 151:A323
8. Hebert PC, Drummond AJ, Singer J, Bernard GR, Russell JA (1993) A simple multiple system organ failure scoring system predicts mortality of patients who have sepsis syndrome. Chest 104:230–235
9. Vincent JL, De Mendonça A, Cantraine F, Moreno R, Takala J, Suter P, Sprung C, Colardyn FC, Blecher S (1998) Use of the SOFA score to assess the incidence of organ dysfunction/failure in intensive care units: results of a multicentric, prospective study. Crit Care Med 26:1793–1800
10. Jacobs S, Zuleika M, Mphansa T (1999) The multiple organ dysfunction score as a descriptor of patient outcome in septic shock compared with two other scoring systems. Crit Care Med 27:741–744
11. Moreno R, Vincent JL, Matos A, De Mendonça A, Cantraine F, Thijs J, Takala J, Sprung C, Antonelli M, Bruining H, Willatts S (1999) The use of maximum SOFA score to quantify organ dysfunction/failure in intensive care. Results of a prospective, multicentre study. Intensive Care Med 25:686–696
12. Lopes Ferreira F, Peres Bota D, Bross A, Melot C, Vincent JL (2001) Serial evaluation of the SOFA score to predict outcome. JAMA 286:1754–1758
13. Livingston BM, Mackenzie SJ, MacKirdy FN, Howie JC (2000) Should the pre-sedation Glasgow Coma Scale value be used when calculating Acute Physiology and Chronic Health Evaluation scores for sedated patients? Crit Care Med 28:389–394
14. ACCP-SCCM Consensus Conference (1992) Definitions of sepsis and multiple organ failure and guidelines for the use of innovative therapies in sepsis. Crit Care Med 20:864–874
15. Knaus WA, Draper EA, Wagner DP, Zimmerman JE (1985) APACHE II: a severity of disease classification system. Crit Care Med 13:818–829
16. Knaus WA, Wagner DP, Draper EA, Zimmerman JE, Bergner M, Bastos PG, Sirio CA, Murphy DJ, Lotring T, Damiano A, Harrell FE (1991) The APACHE III prognostic system: Risk prediction of hospital mortality for critically ill hospitalized adults. Chest 100:1619–1636
17. Le Gall J-R, Lemeshow S, Saulnier F (1993) A new simplified acute physiology score (SAPS II) based on a European/North American multicenter study. JAMA 270:2957–2963
18. Lemeshow S, Teres D, Klar J, Avrunin JS, Gehlbach SH, Rapoport J (1993) Mortality Probability Models (MPM II) based on an international cohort of intensive care unit patients. JAMA 270:2478–2486
19. Goncalves JAJ, Hydo LJ, Barie PS (1998) Factors influencing outcome of prolonged norepinephrine therapy for shock in critical surgical illness. Shock 10:231–236
20. Staubach KH, Schroder J, Stuber F, Gehrke K, Traumann E, Zabel P (1998) Effect of pentoxifylline in severe sepsis: results of a randomized, double-blind, placebo-controlled study. Arch Surg 133:94–100
21. Molnar Z, Shearer E, Lowe D (1999) N-acetylcysteine treatment to prevent the progression of multisystem organ failure: a prospective, randomized, placebo-controlled study. Crit Care Med 27:1100–1104
22. Gruson D, Hilbert G, Vargas F, Valentino R, Chene G, Boiron JM, Reiffers J, Gbikpi-Benissan G, Cardinaud JP (2000) Impact of colony-stimulating factor therapy on clinical outcome and frequency rate of nosocomial infections in intensive care unit neutropenic patients. Crit Care Med 28:3155–3160

23. Martin C, Viviand X, Leone M, Thirion X (2000) Effect of norepinephrine on the outcome of septic shock. Crit Care Med 28:2758–2765
24. Epstein CD, Peerless JR, Martin JE, Malangoni MA (2000) Comparison of methods of measurements of oxygen consumption in mechanically ventilated patients with multiple trauma: the Fick method versus indirect calorimetry. Crit Care Med 28:1363–1369
25. Vanderschueren S, De Weerdt A, Malbrain M, Vankersschaever D, Frans E, Wilmer A, Bobbaers H (2000) Thrombocytopenia and prognosis in intensive care. Crit Care Med 28:1871–1876
26. Kylanpaa-Back ML, Takala A, Kemppainen EA, Puolakkainen PA, Leppaniemi AK, Karonen SL, Orpana A, Haapiainen RK, Repo H (2001) Procalcitonin, soluble interleukin-2 receptor, and soluble E-selectin in predicting the severity of acute pancreatitis. Crit Care Med 29:63–69
27. Briegel J, Forst H, Haller M, Schelling G, Kilger E, Kuprat G, Hemmer B, Hummel T, Lenhart A, Heyduck M, Stoll C, Peter K (1999) Stress doses of hydrocortisone reverse hyperdynamic septic shock: a prospective, randomized, double-blind, single-center study. Crit Care Med 27:723–732
28. Abid O, Akca S, Haji-Michael P, Vincent JL (2000) Strong vasopressor support may be futile in the intensive care unit patient with multiple organ failure. Crit Care Med 28:947–949
29. De Gaudio AR, Adembri C, Grechi S, Novelli GP (2000) Microalbuminuria as an early index of impairment of glomerular permeability in postoperative septic patients. Intensive Care Med 26:1364–1368
30. Tschaikowsky K, Sagner S, Lehnert N, Kaul M, Ritter J (2000) Endothelin in septic patients: effects on cardiovascular and renal function and its relationship to proinflammatory cytokines. Crit Care Med 28:1854–1860
31. Rhodes A, Gabe SM, Wendon JA (2000) A prospective study of gastric mucosal ischaemia in paracetamol-induced acute liver failure. Intensive Care Med 26:1268–1271
32. Hubacek JA, Stuber F, Frohlich D, Book M, Wetegrove S, Ritter M, Rothe G, Schmitz G (2001) Gene variants of the bactericidal/permeability increasing protein and lipopolysaccharide binding protein in sepsis patients: gender-specific genetic predisposition to sepsis. Crit Care Med 29:557–561
33. Bernard GR, Vincent JL, Laterre PF, LaRosa SP, Dhainaut JF, Lopez-Rodriguez A, Steingrub JS, Garber GE, Helterbrand JD, Ely EW, Fisher CJ Jr (2001) Efficacy and safety of recombinant human activated protein C for severe sepsis. N Engl J Med 344:699–709
34. Moreno R, Miranda DR, Matos R, Fevereiro T (2001) Mortality after discharge from intensive care: the impact of organ system failure and nursing workload use at discharge. Intensive Care Med 27:999–1004
35. Oda S, Hirasawa H, Sugai T, Shiga H, Nakanishi K, Kitamura N, Sadahiro T, Hirano T (2000) Comparison of Sepsis-related Organ Failure Assessment (SOFA) score and CIS (cellular injury score) for scoring of severity for patients with multiple organ dysfunction syndrome (MODS). Intensive Care Med 26:1786–1793
36. Janssens U, Graf C, Graf J, Radke PW, Konigs B, Koch KC, Lepper W, Vom Dahl J, Hanrath P (2000) Evaluation of the SOFA score: a single centre experience of a medical intensive care unit in 303 consecutive patients with predominantly cardiovascular disorders. Intensive Care Med 26:1037–1045