Predictors of mortality in a medical intensive care unit

C. E. EAPEN, K. THOMAS, A. M. CHERIAN, L. JEYASEELAN, D. MATHAI, G. JOHN

ABSTRACT

Background. Scoring systems to predict mortality in intensive care units have been developed in western populations. There is a need to identify and validate prognostic variables in the Indian context. We compared two scoring systems to predict the discharge outcome in patients admitted to a medical intensive care unit.

Methods. Five hundred patients admitted to a medical intensive care unit were studied prospectively. Modified acute physiology and chronic health evaluation II (APACHE II) score and modified organ system failure (OSF) score were applied on the day of admission to the intensive care unit. The scores obtained by the two systems were compared using the area under the curve approach. The likelihood ratios were calculated for predicting discharge outcome.

Results. The modified OSF score predicted discharge outcome better than the modified APACHE II score—receiver operating characteristic curve area (standard error–area) 0.7062 (0.0244) and 0.6068 (0.0267) for the modified OSF and the modified APACHE II scores, respectively. This was statistically significant ($p<0.001$). The likelihood ratio for the modified OSF score for different cut-off points varied from 0.27 to 5.49, while the likelihood ratio for the modified APACHE II score varied from 0.11 to 2.08. This means that for an intensive care unit with a 30% overall mortality, the modified OSF score could separate patients with 10% to 70% mortality, while the modified APACHE II score could predict only 5% to 47% mortality.

Conclusion. The modified OSF score was superior to the modified APACHE II score in predicting mortality in patients admitted to the medical intensive care unit.

Natl Med J India 1997;10:270–2

INTRODUCTION

It is important to be able to predict the outcome of patients admitted to an intensive care unit (ICU) so that scarce resources can be more optimally utilized. Many scoring systems have been evolved for this purpose as well as to assess the severity of illness in various clinical situations. These scoring systems are useful in assuring comparability of patients entered into randomized prospective controlled trials and in predicting prognosis.

We prospectively compared two mortality predicting scoring systems—the modified APACHE II (acute physiology and chronic health evaluation II) and the modified OSF (organ system failure) in patients admitted to the medical ICU in our hospital.

Christian Medical College, Vellore 632004, Tamil Nadu, India
C. E. EAPEN, K. THOMAS, A. M. CHERIAN, D. MATHAI, G. JOHN Department of Medicine
L. JEYASEELAN Department of Biostatistics
Correspondence to G. JOHN

PATIENTS AND METHODS

The Christian Medical College Hospital is a 1400-bedded university teaching hospital with 6 critical care units. These are the medical ICU, surgical ICU, neurology/neurosurgery ICU, cardiothoracic ICU, coronary care unit and the burns unit. The medical ICU is an 11-bedded unit, admits around 700 patients per year and almost half of them require mechanical ventilation.

The two scoring systems were applied on the day of admission to the ICU and were compared with the discharge outcome. The discharge outcome was categorized as alive, dead and discharged on request. The term 'discharged on request' included those patients whose families decided against further treatment in hospital in view of the poor prognosis and did not want the patient to die in the hospital. Data collection was done by a single investigator.

Modified APACHE II score

The modified APACHE II score was adapted from the APACHE II score.[1] The Glasgow Coma Scale (GCS) or neurological failure was not included in the modified APACHE II score. Patients admitted to the medical ICU often require use of sedatives or muscle relaxants during endotracheal intubation or mechanical ventilation. The use of these drugs would confound the assessment of the patient's neurological status by the GCS score.

The GCS was developed for grading the severity of traumatic head injury.[2] Its use as a prognostic variable is greatest in the immediate post-injury phase. However, endotracheal intubation precludes verbal response. As many patients are rendered unresponsive due to sedation and neuromuscular blockade during resuscitation, it leads to a serious problem in scoring. Post-resuscitation scoring can be done only after these pharmacological agents have been metabolized.[3] Such confounders interfered with the direct assessment of at least one component of the GCS in 38% of patients and in the same study the GCS could not be confidently assigned in almost half the patients.[4] In entering the GCS in APACHE II, it is assumed to be 15 in sedated ventilated patients when neurological problems are unlikely to be present.[5] The latest version of the APACHE scoring system (APACHE III) has modified the use of the GCS variable in scoring because of these problems.[6]

As our study was conducted in a medical ICU (trauma patients were not included) and since an assumed GCS could be a confounding variable (47% of patients studied were mechanically ventilated), we did not include GCS or neurological failure in the scoring systems.

Thus, we studied 11 physiological variables (to give the modified acute physiology score) instead of the 12 variables used in the APACHE II score. The possible range of the score was 0 to 54 points and the modified APACHE II score was obtained by adding the modified acute physiology score to the age points and chronic health points.

Modified OSF score

This score was adapted from the OSF score[7] in which neurological scoring is not performed in a paralysed or sedated patient; and the patient is not considered to be in neurological failure. When the patient is intubated but not sedated, clinical judgement is used to estimate verbal response.[7] We excluded neurological failure (for the reasons discussed above). Thus, the modified OSF score included cardiovascular, respiratory, renal and haematological failure (one point was recorded for each organ system which failed) and the range of the score was 0–4 points.

Statistical analysis

The scores obtained by the two scoring systems were compared using receiver operating characteristic (ROC) curves.[8,9] The likelihood ratios were calculated for predicting discharge outcome using both scoring systems at different cut-off points.

RESULTS

Five hundred patients admitted to the medical ICU from December 1991 to March 1993 were studied prospectively. The patient characteristics are provided in Table I. The admission diagnoses included drug overdose (28%), respiratory failure (18%), septicaemia (9%), chronic liver disease (4%), tetanus (5%) snake bite (3%), diabetic ketoacidosis (3%) and miscellaneous (30%), which included gastrointestinal bleeding, falciparum malaria, scorpion sting, ingestion of corrosives and accelerated hypertension.

Tables II and III show that rising scores in both the scoring systems were associated with increasing mortality rates. They also give the likelihood ratios for different cut-off levels of both the scoring systems which were 0.27–5.49 for the modified OSF score and 0.11–2.08 for the modified APACHE II score. ROC curves were constructed for the two scoring systems and are shown in Fig. 1. The ROC area and standard error (area) of the modified OSF score were 0.7062 and 0.0244, and the modified APACHE II score were 0.6068 and 0.0267, respectively. The difference in the area under the curve was statistically significant ($p<0.001$). These show that the modified OSF score was superior to the modified APACHE II score in predicting mortality.

The above data were analysed excluding the patients discharged on request. On analysing the results by including the patients discharged on request with the patients who died, we got similar results.

DISCUSSION

A large number of scoring systems have been designed to predict the outcome of seriously ill and injured patients. These include the APACHE I, II and III scores, OSF score, MPM (Mortality Prediction Model), MPM II, CIS (Condition Index Score), TISS (Therapeutic Intervention Scoring System), SAPS (Simple Acute Physiology Score), SAPS II and ODIN (Organ Dysfunction and infection) scores.[1,7,10–16] Most of these scoring systems have been developed in western populations. Their applicability in patient populations in developing countries is currently being studied.[17] With sophisticated and expensive technologies becoming increasingly available in India there is a need to develop or adapt scoring systems valid for our population.

We studied two mortality predicting scoring systems in patients admitted to our medical ICU. As the score increased (by either scoring system), the mortality rate also increased (Tables II and III). However, the mortality rate of patients with a modified APACHE II score between 41 and 45 was only 50% compared to

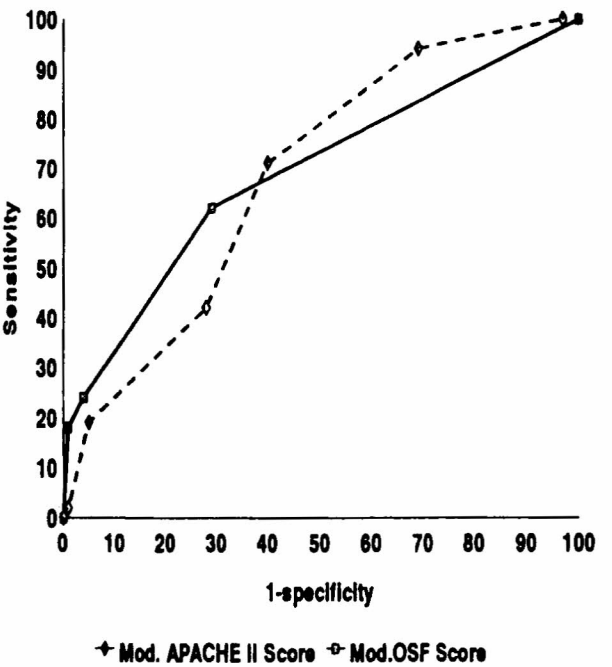

FIG 1. Receiver operating characteristic (ROC) curve

TABLE I. Patient characteristics

n	500
Age (range)	13–84 years
Sex	311 male, 189 female
Patients requiring ventilation	232/500 (47)
Discharge outcome	
Alive	317 (63.4)
Dead	162 (32.4)
Discharged on request	21 (4.2)

Figures in parentheses are percentages

TABLE II. Modified APACHE II score *v.* outcome

Modified APACHE II score	Dead (%)	Alive (%)	Likelihood ratio for death
11–15	0	100	
16–20	10	90	0.11
21–25	28.6	71.4	0.4
26–30	40	60	0.66
31–35	47.4	52.6	0.90
36–40	67.5	32.5	2.08
41–45	50	50	1.0

21 patients discharged on request have been excluded

TABLE III. Modified organ system failure (OSF) score *v.* outcome (*n*=479)

Modified OSF score	Dead (%)	Alive (%)	Likelihood ratio for death
0	21.5	79.5	0.27
1	44.2	55.8	0.79
2	70	30	2.33
>3	84.6	15.4	5.49

21 patients discharged on request have been excluded

67.5% among patients with scores between 36 and 40. This is probably because there were very few patients in the former group (n=6) compared to the latter (n=41).

When compared using ROC curves, the modified OSF score was better than the modified APACHE II score in predicting mortality. In our study, the modified OSF score was able to predict up to 70% mortality in those with a failure of >3 organ systems while the modified APACHE II score could obtain a maximum prediction of less than 50%. This was thought to be both clinically and statistically significant (p=0.001).

The likelihood ratio (LR) expresses the odds that mortality would be expected in a patient with (as opposed to one without) a certain score.[18] A clinician dealing with the results of any test is primarily interested in the post-test probability for the test results at different cut-off levels. However, the post-test probability of any disease, given a test result, is highly prevalence-dependent. While sensitivity and specificity do not have a direct implication on post-test probability, the LR is relatively prevalence-independent and at the same time is directly related to post-test probability. Using the LR one can directly calculate the mortality rate in any setting using a calculator or a nomogram.[19] In an ICU with an overall mortality rate of 30% (i.e. pre-test probability of 30%), identifying patients with a modified OSF score of>3 increases the post-test probability to 70%.

ICUs at different locations admit patients with different diseases and severity. Therefore, the mortality rate (prevalence) can be highly unit-dependent. The data generated in a tertiary care ICU are unlikely to be of use for small ICUs or vice versa.

A recent multicentre study from Portugal which compared SAPS II (Simplified Acute Physiology Score II) and APACHE II score in mixed medical–surgical ICUs showed that the SAPS II score discriminated the outcome significantly better than the APACHE II score.[20]

In this study, 299 patients (59.8%) did not have any organ system failure by the modified OSF score. Less stringent criteria to define organ failure would help identify milder organ dysfunction. A study using the ODIN (Organ Dysfunction and Infection) score had only 14.2% of patients with no organ dysfunction at the time of admission to an ICU.[16]

The advantages of both the scoring systems are that reliable predictions of survival are available within 24 hours of admission and that the measurements used are easy to obtain.

The subjective weights assigned to various physiological variables to rank severity in these scoring systems could cause a perceptual bias.[21] For example, in the modified OSF score, a haematocrit level of 15% is considered to be haematological failure eliciting a score of one (out of a range of 0–4). On the other hand, a haematocrit level of 15% in the modified APACHE II score adds only one point to the total score (range of score being 0–54). This could partly account for the superiority of the modified OSF score over the modified APACHE II score in the present study.

In conclusion, we have compared the modified APACHE II score and the modified OSF score applied in patients on the day of admission to a medical ICU. The modified OSF score was found to be clinically and statistically superior to the modified APACHE II score in predicting mortality and was also simpler to apply.

ACKNOWLEDGEMENT

This project was funded by a grant from the Fluid Research Fund of the Christian Medical College and Hospital, Vellore, Tamil Nadu.

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