PATIENT OUTCOME AND INTENSIVE CARE RESOURCE ALLOCATION USING APACHE II

S C Lim, A C K Fok, Y Y Ong

ABSTRACT

A prospective study of seventy consecutive admissions to the Medical Intensive Care Unit (MICU) of a local hospital over a five-month period was conducted with the aim of developing objective criteria for critical care resource allocation. Patients gaining admission were subjected to APACHE II scoring and their progress followed till they recovered from their illness or perished.

The mean APACHE II score of patients who recovered from their illness or perished were 12.96 and 28.52 respectively ($p< 0.001$). 91.5% of all patients who recovered had an APACHE II score of below 21 whereas 82.6% of those who died had an APACHE II score of more than 23.

Males generally had poorer outcome than females [47% mortality vs 8% ($p < 0.001$)] although their mean ages were comparable [47.6 years vs 46.6 years respectively ($p = 0.85$)]. The mean APACHE II scores of male and female patients were significantly different [male = 20.6 vs female = 13.6 ($p < 0.005$)] and this partly accounted for the poorer outcome of males.

The APACHE II score has considerable predictive value on the final outcome of patients admitted to the MICU. When ICU beds are short, the allocation of such beds may be made with consideration of the APACHE II Score which identifies the patient who is most likely to benefit from ICU care.

Keywords: *APACHE II, intensive care, critical care resource allocation, outcome*

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INTRODUCTION

Critical care resources in acute teaching hospitals are seldom in over supply. Therefore, the use of objective criteria for admission of patients into critical care is an important aspect of medical practice. The chief consideration lies in selecting the patient who is likely to benefit from maximal care available in the ICU. Therefore, any objective assessment that has strong predictive value on the likely outcome of the patient will be a useful parameter in deciding on admission to critical care. In this light, the usefulness of the APACHE II score on such decision making was studied.

OBJECTIVES

To validate the usefulness of APACHE II score in predicting outcome of patients admitted to the MICU and in critical care resource allocation in a local hospital.

MICU SETUP

The hospital is a 1,500-bedded acute teaching hospital with three general medical units which manage a total of 300 beds. Its 8-bedded ICU serves not only all the three general medical units but also receives patients from the haematology, nephrology, neurology and oncology departments of the institution.

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DESIGN

The study period spanned the months of April through August 1992.

All patients incumbent in the Medical Intensive Care Unit at the commencement of study were excluded from analysis. Consecutive patients gaining admission to the MICU during the aforesaid period were followed up until they were discharged from the unit or perished from their illness. Patients admitted with a diagnosis of acute myocardial infarction were excluded as the outcome of such patients have been previously defined. Clinical and demographic data were recorded by a single author (ACKF) who during the review period was not involved in the management of patients in the MICU. APACHE II scoring (Annex 1) was done at the point of or within a day of admission. Alphanumeric data were transferred to numeric format for analysis. Numeric and transformed data were analysed on the microcomputer-based SPSS statistical package.

RESULTS

Patients demography and main diagnoses at the MICU admission are shown in Tables I and II.

The distribution of APACHE II score of patients who recovered or perished are shown in Fig 1 and 2 respectively.

Table III shows the mean APACHE II score of those patients who recovered vs those who perished. 91.5% of all patients who recovered had an APACHE II score below 21 (Fig 3) whereas 82.6% of those patients who died had an APACHE II

Table I – Patient demography

Sex	Males	45	(64%)
	Females	25	(36%)
Ethnic group	Chinese	58	(83%)
	Malay	6	(9%)
	Indian	3	(4%)
	Others	3	(4%)
Age	Range	14 - 86	yr
	Mean	47	yr
	SD	20.7	yr

Annex 1 – The APACHE II severity of disease classification system

Physiologic variable	+4	+3	+2	+1	0	+1	+2	+3	+4
Temperature °C	≥ 41	39-40.9		38.5-38.9	36-38.4	34-35.9	32-33.9	30-33.9	≤ 29.9
Mean arterial pressure/mm Hg	> 160	130-159	110-129		70-109		55-69		≤49
Heart rate (ventricular response)	> 180	140-179	110-139		70-109		55-69	40-54	≤39
Resp rate (Un/ventilated)	≥ 50	35-49		25-34	12-24	10-11	6-9		≤ 5
Oxygenation A_aDO_2 or PaO_2 mmHg FiO_2 > 0.5 record A_aDO_2 FiO_2 < 0.5 record only P_aO_2	≥ 500	350-499	200-349		< 200 > 70	61-70		55-60	< 5
Arterial pH	> 7.7	7.6-7.69		7.5-7.59	7.33-7.49		7.25-7.32	7.15-7.24	< 7.15
Serum sodium (mmol/L)	≥ 180	160-179	155-159	150-154	130-149		120-129	111-119	≤ 110
Serum potassium (mmol/L)	≥ 7	6.0-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		≤ 2.5
Creatinine µmol/L (double pts if in ARF)	≥ 310	203-309	132-202		53-131		< 53		
Haematocrit %	≥ 60		50-59.9	46-49.9	30-45.9		20-29.9		< 20
Total white x 10^9/L	≥ 40		20-39.9	15-19.9	3-14.9		1-2.9		< 1
Glasgow coma score = 15 - GCS									
[A] APS (sum of 12 variables)									
Serum HCO_3 (use if no ABG)	≥ 52	41-51.9		32-40.9	22-31.9		18-21.9	15-17.9	< 15

[B] AGE POINTS

≤ 44	0
45-54	2
55-64	3
65-74	4
≥ 75	5

[C] CHRONIC HEALTH POINTS

If the patient has a history of severe organ system insufficiency or is immunocompromised, assign points as follows:
a. nonoperative or emergency postop patients - 5 points
b. elective postoperative patients - 2 points
DEFINITIONS: Organ insufficiency or immunocompromise must be evident prior to this hospital admission.
LIVER: Biopsy proven cirrhosis and documented portal HPT; episodes of past GI bleeding from portal HPT; or prior episodes of liver failure/encephalopathy/coma. CVS: New York Heart Association Class IV. RENAL: On chronic dialysis. RESPIRATORY: Lung disease causing severe exercise restriction; or documented chronic hypoxia hypercapnia, pulm HPT, 2° polycythaemia. IMMUNOCOMPROMISED: Patient received steroids/DXT/chemoRx; leukaemia, HIV

APACHE II SCORE

[A] APS pts _____
[B] Age pts _____
[C] Chronic Healths pts _____
APACHE II _____

Table II – Primary diagnosis at ICU admission

Respiratory failure	21 (30.0%)
Septicaemia	11 (15.7%)
Dengue fever	6 (8.6%)
Cerebrovascular accident	4 (5.7%)
Diabetic ketoacidosis/Non-ketotic coma	5 (7.1%)
Heat stroke/exhaustion	4 (5.7%)
Congestive cardiac failure	5 (7.1%)
Encephalitis/meningitis	3 (4.3%)
Poisoning	3 (4.3%)
End-stage renal failure/acute renal failure	3 (4.3%)
Asthma	2 (2.9%)
Malaria	2 (2.9%)
Misc (post ERCP haemorrhage)	1 (1.4%)
	n = 70 (100%)

score of more than 23 (Fig 4). The range of APACHE II score of those who recovered vs those who perished were 1 to 33 and 9 to 44 respectively (Table III). The mean duration of stay in the MICU of those patients who recovered vs those who perished were similar [4.79 days vs 4.83 days (p = 0.97)]. Males generally fared worse than females [47% mortality vs 8% (p < 0.001)] although their mean ages were comparable [47.6 yrs vs 46.6 yrs respectively (p = 0.85)]. The mean APACHE II scores of male and female patients were significantly different [male = 20.6 vs female = 13.6 (p < 0.005)] (Table IV).

Fig 1 – Frequency distribution of APACHE II score in survivors

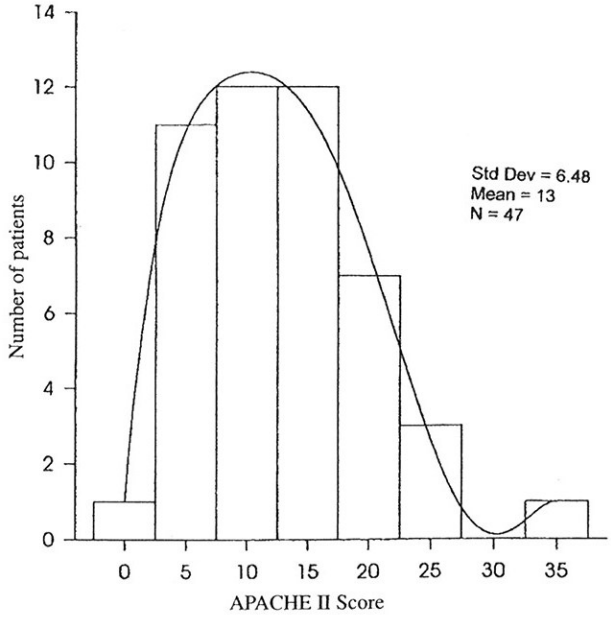

Fig 2 – Frequency distribution of APACHE II Score in patients who perished

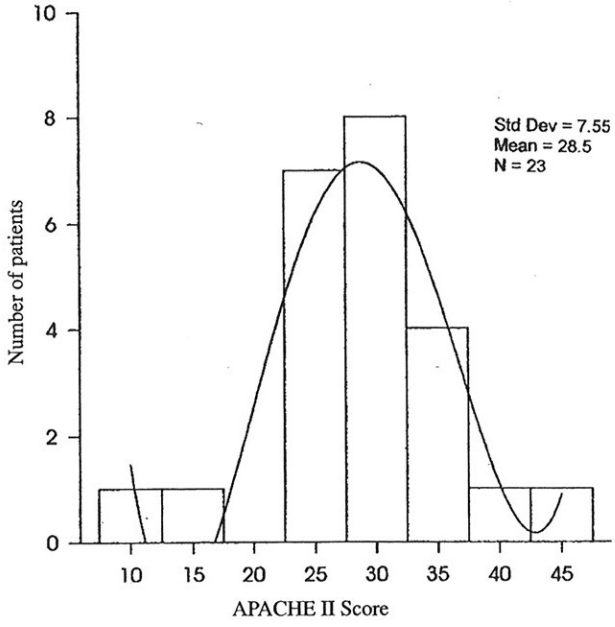

Fig 3 – Distribution of APACHE II Score of survivors

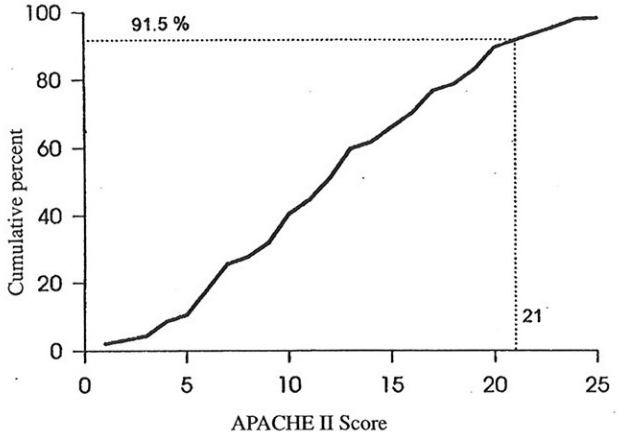

Fig 4 – Distribution of APACHE II Score of patients who perished

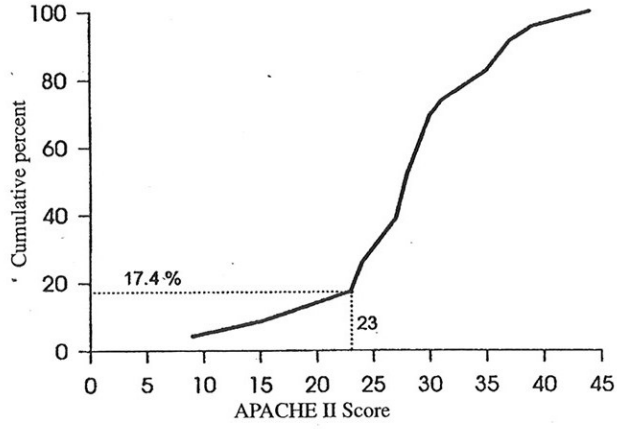

Table III – Parameters of patients who recovered vs those who perished.

	Recovered (n = 47)	Perished (n = 23)	P
Mean APACHE II Score	12.96 ± 6.48	28.52 ± 7.55	<0.001
Cumulative % APACHE II Score	91.50 % < 21	82.60 % > 23	—
Range of APACHE II Score	1 to 33	9 to 44	—
Mean duration of MICU stay (days)	4.79	4.83	0.970

Table IV – Characteristics and outcome of male and female patients admitted to MICU

	Male (n = 45)	Female (n = 25)	P
% of patients who perished	47%	8%	<0.001
Mean age	47.60	46.60	0.850
Mean APACHE II Score	20.60	13.60	<0.005

DISCUSSION

McClish [1] and Henning [2] have shown in their studies that 20% to 30% of ICU admissions consist of monitoring patients who are extremely unlikely to require active treatment. At the other end of the spectrum, there is a group of severely ill patients requiring burdensome intensive treatment, yet have little chance of recovery.

Hence, MICU resource allocation should be directed at identifying patients who are most likely to benefit from maximal care available in the MICU. Otherwise, the MICU would not be cost effective or becomes an expensive resource used to support patients with virtually hopeless outcomes. The APACHE II score is therefore proposed to be used as an objective reference in selecting patients for admissions into the MICU.

The data presented unequivocally supports the proposal of using the APACHE II score as a reference in triaging MICU admissions.

Those patients who recovered had a statistically significantly lower mean APACHE II score compared to those who perished. Ninety percent of patients who survived had an APACHE II score equal to or less than 21 and no patient with an APACHE II score below 9 perished. This suggests that patients with a score between 9 and 21 are candidates who would benefit most from ICU management. On the other hand, 82.6% of patients who perished had an APACHE II score equal to or above 23 and only one patient with a score greater than 24 survived in the MICU of SGH. Hence, when ICU beds are scarce, one should consider carefully before admitting patients who score beyond 24 to the MICU, as these patients are virtually unsalvageable.

Furthermore, since the demography of this cohort of patients bore close resemblance to that reported by Fok [3] and Lee [4], the authors believe that the above data would also be relevant to future cohort of patients.

However, the authors acknowledge that the absolute "cut-off" APACHE II score from the MICU of our hospital cannot be extrapolated to the MICU of a different hospital. Hence, it would be more relevant for individual hospital to ascertain the APACHE

II score predictive of outcome in its own MICU. There exists, however, another way of assessing the patients using the APACHE II score ie to observe the change and trend of the score of each patient daily.

It is generally believed that individual patient decisions cannot be based solely on information from records of past patients. However, studies by Kruse, McClish and Larvins have shown that outcome prediction by prognostic scoring system appears to be at least as good as, and occasionally superior to clinical judgment made by critical care physicians and nurses [5-9].

Having said that, the statistical predictive power of APACHE score can be further improved by:

1. Redefining the variables and their weightage in the APS score and by improving the precision of disease classification [10].
2. Obtaining a large, nationally representative database from which individual outcome prediction with narrow confidence limits can be based [11].
3. As mentioned earlier, daily ICU APACHE data update on each patient as both the absolute value of the APACHE score and its rate and degree of change over time are important in outcome prediction. This is best achieved with an automated data collection using a computer model [9].

In spite of the above data, one should not depend on the reliability of APACHE II score as absolute. **The authors recognise that it is an invaluable guide in situations where two or more patients are competing for a single ICU bed. The patient who is more likely to benefit should be given preference to one who is virtually unsalvageable.**

Interestingly, the average duration of stay of both groups of patients (survivors and non-survivors) are similar. This suggests that prolonging the stay of unsalvageable patients in the MICU does not alter the outcome appreciably.

Unexpectedly, the data also suggest that male gender is a poor prognostic factor independent of age. Male patients also have a statistically significantly higher APACHE II score upon admission to the MICU as compared to the female counterparts. This might be attributable to the social custom of male patients generally refraining from seeking medical attention unless they are very ill which in part accounts for their poorer outcome.

In conclusion, having known the strengths and limitations of the APACHE II score, it can be a useful objective guide in the MICU resource allocation. It is reasonable to incorporate it into the decision making process in the day-to-day running of the MICU.

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