APACHE II : Preliminary report on 100 Intensive Care Unit cases in University Hospital, Kuala Lumpur

*G.S. Teoh, MBBS (Malaya)
Medical Officer
*K.K. Mah, MBBS (Malaya)
Medical Officer
*Sufian Abd. Majid, MD (UKM)
Medical Officer
*Streram, MBBS (Mysore)
Medical Officer
M.K. Yee**, MBBS (Malaya), FFARCS (I)
Consultant Anaesthesiologist

**Department of Anaesthesia, University Hospital, Kuala Lumpur.*

*** Fatimah Hospital, Ipoh, Perak*
Formerly Lecturer, University Hospital, Kuala Lumpur

Summary

A good overall assessment of the severity of illnesses of patients admitted to a general intensive care unit (ICU) is not without problems. The APACHE (acute physiology and chronic health evaluation) prognostic scoring system enables us to stratify acutely ill patients and compare efficiency of ICU therapy in different hospitals. This preliminary study carried out on 100 consecutive admissions to the ICU in University Hospital, Kuala Lumpur showed the spectrum of ICU admissions and the direct relationship between APACHE II score and mortality.

Key words: APACHE II, outcome prediction, prognostic scoring system, preliminary usage in UHKL.

Introduction

The APACHE (acute physiology and chronic health evaluation) prognostic scoring system was first developed in the United States in the George Washington University Medical Centre by William Knaus et al[1]. Their initial goal was to develop a better methodology of measuring case mix among ICU patients. It was noted that death rates varied among ICUs and it was not known whether the cause of the outcome variations was due to differences in therapeutic efficacy or case-selection criteria of admission to various ICUs.

The APACHE approach to severity measurement uses the conceptual model that a patient's prior risk of death from an acute illness was a function of his major disease, his physiological reserve (which was influenced by his age and the presence of chronic diseases), along with a major contribution from the acute severity of disease as determined by derangements in acute physiologic balance. The basis for

APACHE's development was the hypothesis that the severity of acute disease can be measured by quantifying the degree of abnormality of multiple physiologic variables.

The original APACHE system provides weightings for 34 potential physiologic measures, the sum of which yields an acute physiologic score (APS). In the APACHE II[2], the number of physiologic measurements was reduced to 12. There is increased weightage for acute renal failure[3], and Glasgow coma score[4].

The APACHE II scoring system was commenced in the ICU in University Hospital, Kuala Lumpur (UHKL) on August 1, 1990 and this preliminary report is based upon the first 100 consecutive admissions.

Patients and Method

The first 100 consecutive admissions to the ICU in UHKL from 1 August ,1990 to September 23, 1990 were studied in this initial report. Admissions were from the operating theatres directly or from the recovery room; referrals from all wards (Medical, Surgical, Paediatrics); and from the Accident and Emergency ward. Patients admitted solely to ICU for the purpose of pain relief (epidural opiates or thoracic epidurals) were excluded from this study. Patients who underwent cardiac operations were admitted post-operatively to the Cardiac Intensive Care Unit and hence were excluded.

The APS is determined from the worst physiologic value during the initial 24 hours following ICU admission. The worst value may be the highest or lowest value from normal. All 12 physiologic variables must be scored to obtain the APS.

Age points were assigned accordingly. Chronic health points were assigned depending on the mode of ICU admissions; five points for non-operative or emergency post-operative patients and two points for elective post-operative patients.

The APACHE II score is then calculated as the sum of the APS, age point and chronic health point (refer Appendix A[2]).

The death rate in this study is the observed hospital death rate i.e. in the ICU or in the wards, following discharge from ICU.

Results

A total of 100 ICU patients were studied with ages ranging from 1 month to 82 years. The age distribution is illustrated in Table 1. The largest proportion of the patients (20%) fell into the 61-70 year age group.

Table 2 shows the diagnostic category into which the admissions were classified and the corresponding mortality. There was 100% mortality in those patients admitted with sepsis, haemorrhagic shock and post cardiac arrest (for cerebral resuscitation) and 42% mortality in trauma/emergency neurological patients.

The patients were divided into non-operative and operative categories. There were 43 non-operative and 57 operative patients. The distribution of APACHE II scores in these admissions is illustrated in

Appendix A.

THE APACHE II SEVERITY OF DISEASE CLASSIFICATION SYSTEM

PHYSIOLOGIC VARIABLE	HIGH ABNORMAL RANGE					LOW ABNORMAL RANGE			
	+4	+3	+2	+1	0	+1	+2	+3	+4
TEMPERATURE — rectal (°C)	○ ≥ 41°	○ 39°-40.9°		○ 38.5°-38.9°	○ 36°-38.4°	○ 34°-35.9°	○ 32°-33.9°	○ 30°-31.9°	○ ≤ 29.9°
MEAN ARTERIAL PRESSURE — mm Hg	○ ≥ 160	○ 130-159	○ 110-129		○ 70-109		○ 50-69		○ ≤ 49
HEART RATE (ventricular response)	○ ≥ 180	○ 140-179	○ 110-139		○ 70-109		○ 55-69	○ 40-54	○ ≤ 39
RESPIRATORY RATE — (non-ventilated or ventilated)	○ ≥ 50	○ 35-49		○ 25-34	○ 12-24	○ 10-11	○ 6-9		○ ≤ 5
OXYGENATION: A-aDO$_2$ or PaO$_2$ (mm Hg) a. FIO$_2$ ≥ 0.5 record A-aDO$_2$	○ ≥ 500	○ 350-499	○ 200-349		○ < 200				
b. FIO$_2$ < 0.5 record only PaO$_2$					○ PO$_2$ > 70	○ PO$_2$ 61-70		○ PO$_2$ 55-60	○ PO$_2$ < 55
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	○ 6-6.9		○ 5.5-5.9	○ 3.5-5.4	○ 3-3.4	○ 2.5-2.9		○ < 2.5
SERUM CREATININE (mg/100 ml) (Double point score for acute renal failure)	○ ≥ 3.5	○ 2-3.4	○ 1.5-1.9		○ 0.6-1.4		○ < 0.6		
HEMATOCRIT (%)	○ ≥ 60		○ 50-59.9	○ 46-49.9	○ 30-45.9		○ 20-29.9		○ < 20
WHITE BLOOD COUNT (total/mm3) (in 1,000s)	○ ≥ 40		○ 20-39.9	○ 15-19.9	○ 3-14.9		○ 1-2.9		○ < 1
GLASGOW COMA SCORE (GCS): Score = 15 minus actual GCS									
[A] Total ACUTE PHYSIOLOGY SCORE (APS): Sum of the 12 individual variable points									
Serum HCO$_3$ (venous-mMol/L) [Not preferred, use if no ABGs]	○ ≥ 52	○ 41-51.9		○ 32-40.9	○ 22-31.9		○ 18-21.9	○ 15-17.9	○ < 15

[B] AGE POINTS:
Assign points to age as follows:

AGE(yrs)	Points
≤ 44	0
45-54	2
55-64	3
65-74	5
≥ 75	6

[C] CHRONIC HEALTH POINTS
If the patient has a history of severe organ system insufficiency or is immuno-compromised assign points as follows:
a. for nonoperative or emergency postoperative patients — 5 points
or
b. for elective postoperative patients — 2 points

DEFINITIONS
Organ insufficiency or immuno-compromised state must have been evident prior to this hospital admission and conform to the following criteria:

LIVER: Biopsy-proven cirrhosis and documented portal hypertension, episodes of past upper GI bleeding attributed to portal hypertension, or prior episodes of hepatic failure/encephalopathy/coma.

CARDIOVASCULAR: New York Heart Association Class IV.

RESPIRATORY: Chronic restrictive, obstructive, or vascular disease resulting in severe exercise restriction, i.e., unable to climb stairs or perform household duties; or documented chronic hypoxia, hypercapnia, secondary polycythemia, severe pulmonary hypertension (>40mmHg), or respirator dependency.

RENAL: Receiving chronic dialysis

IMMUNO-COMPROMISED: The patient has received therapy that suppresses resistance to infection, e.g., immuno-suppression, chemotherapy, radiation, long term or recent high dose steroids, or has a disease that is sufficiently advanced to suppress resistance to infection, e.g., leukemia, lymphoma, AIDS

APACHE II SCORE
Sum of [A] + [B] + [C]

[A] APS points _____

[B] Age points _____

[C] Chronic Health points _____

Total APACHE II _____

The APACHE II severity of disease classification system.

Table 1 : Age distribution of patients

Age (years)	Number
0 – 10	7
11 – 20	12
21 – 30	13
31 – 40	11
41 – 50	11
51 – 60	16
61 – 70	20
71 – 80	8
> 81	2

Table 2 : Diagnostic category and deaths

Diagnosis	Patients	Deaths
Neurologic		
Trauma / Emergency	12	5
Elective / Post-op	16	1
Resp.insufficiency		
Non-operative	21	0
Operative	10	1
Sepsis	3	3
Gastrointestinal	11	3
Cardiovascular	14	1
Drug overdose	1	0
Haemorrhagic shock	1	1
Metabolic disorder	2	0
Post-cardiac arrest	7	7
Multiple trauma	2	1

Figure 1. Patients were admitted at all levels of severity with APACHE II scores ranging from one to 50. (The worst possible APACHE II score is 71).Of the patients, 51% had an APACHE II score of between 10 – 19. The non-operative patients scored higher and they also showed a wider scatter in their score. These non-operative patients were emergency medical admissions of varying severity.

The APACHE II scores were correlated with hospital mortality in Figure 2. It showed that the mortality was higher with a higher APACHE II score. There were no deaths in the 0–4 APACHE II score group. In the higher ranges of APACHE II score of 30 onwards, there was a 100% mortality except for APACHE II score of 45–49 for which there were no admissions within this group.

Table 3 shows the number of non-operative and operative patients and deaths in each category of APACHE II score. As the number of patients studied was small, there were none in the non-operative group with scores of 30–34 and 45–49, or in the operative group with a score of 35–54.

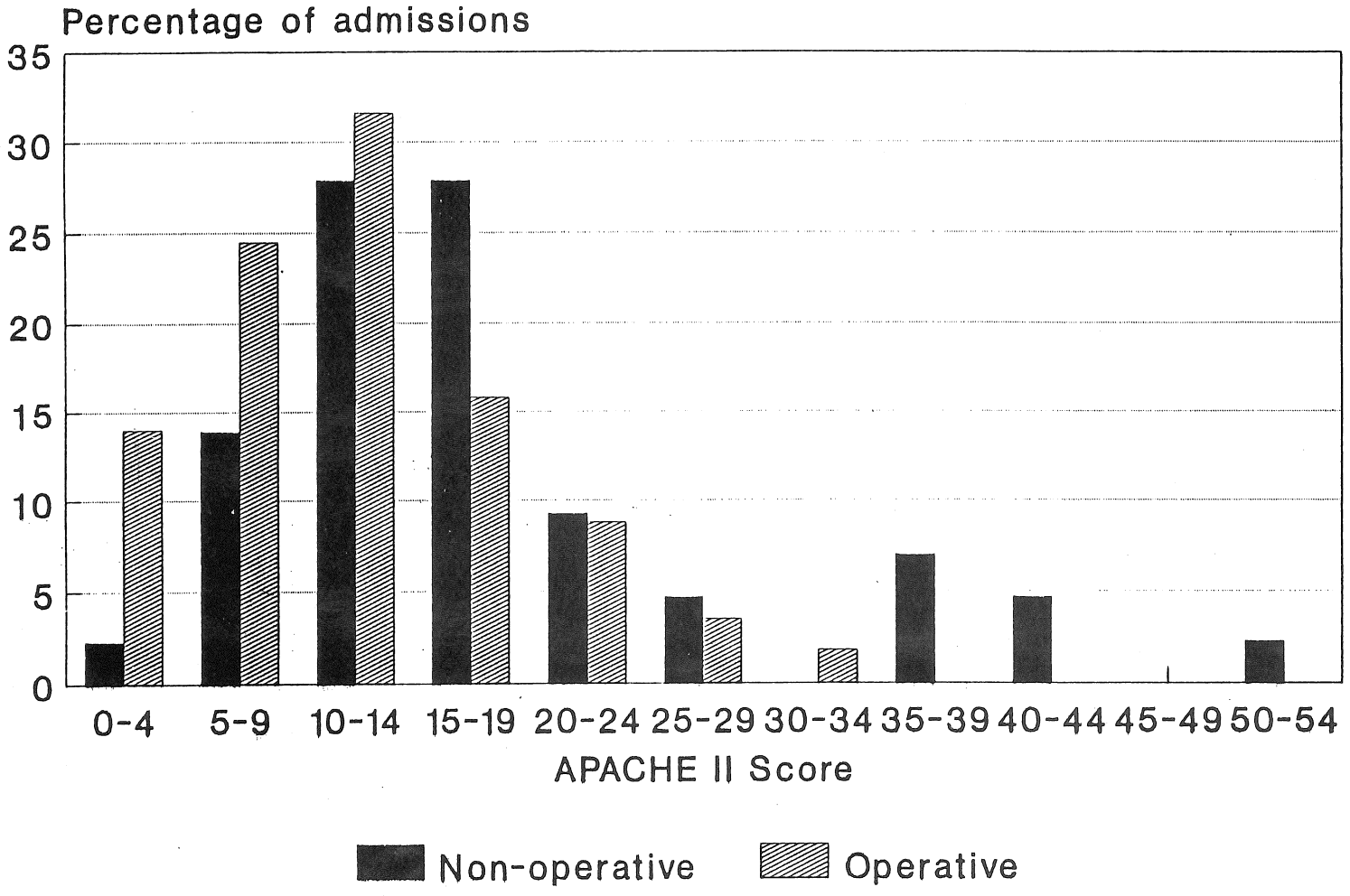

Fig 1. Distribution of APACHE II scores in 100 ICU admissions

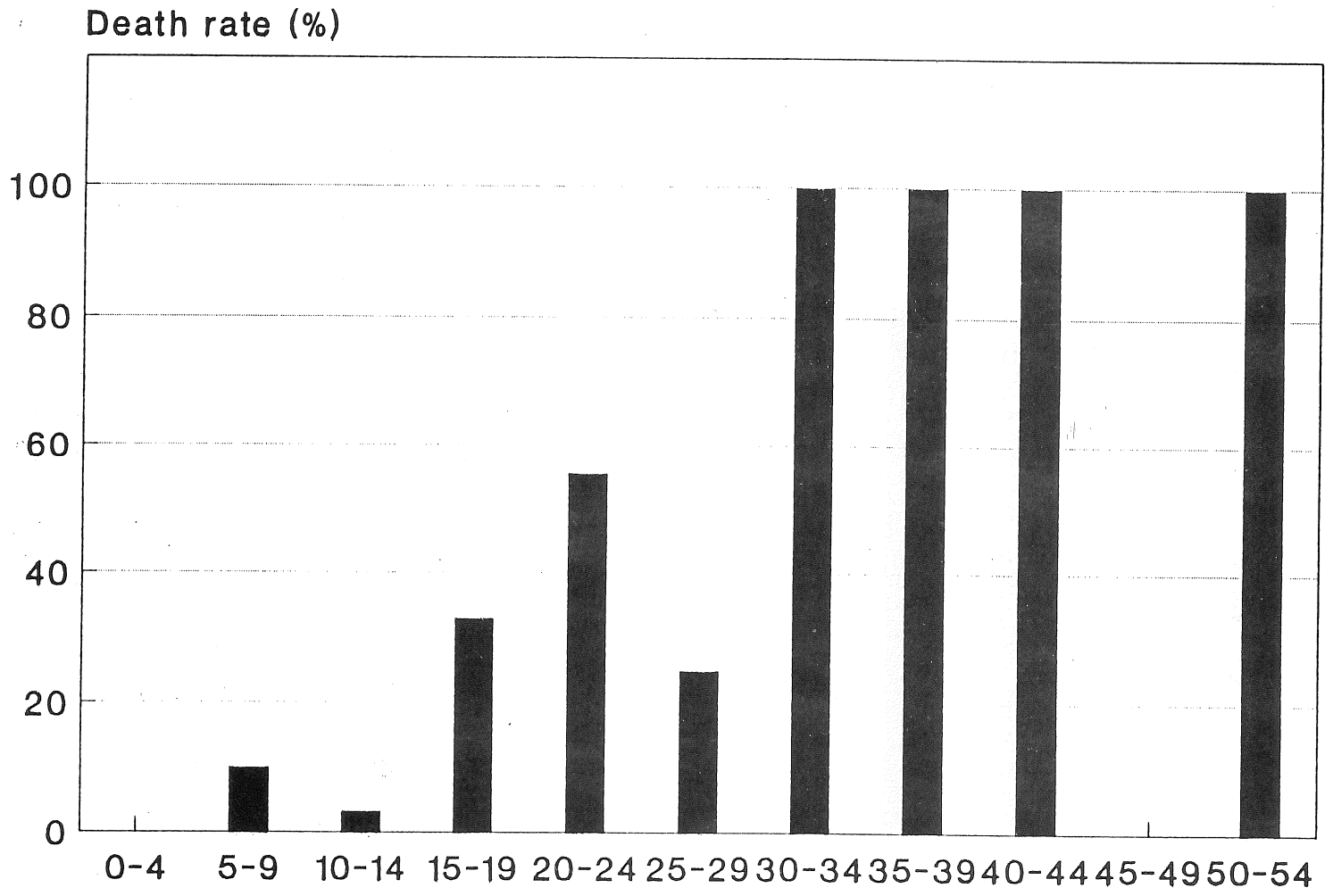

Fig 2. APACHE II scores and hospital mortality in 100 ICU admissions

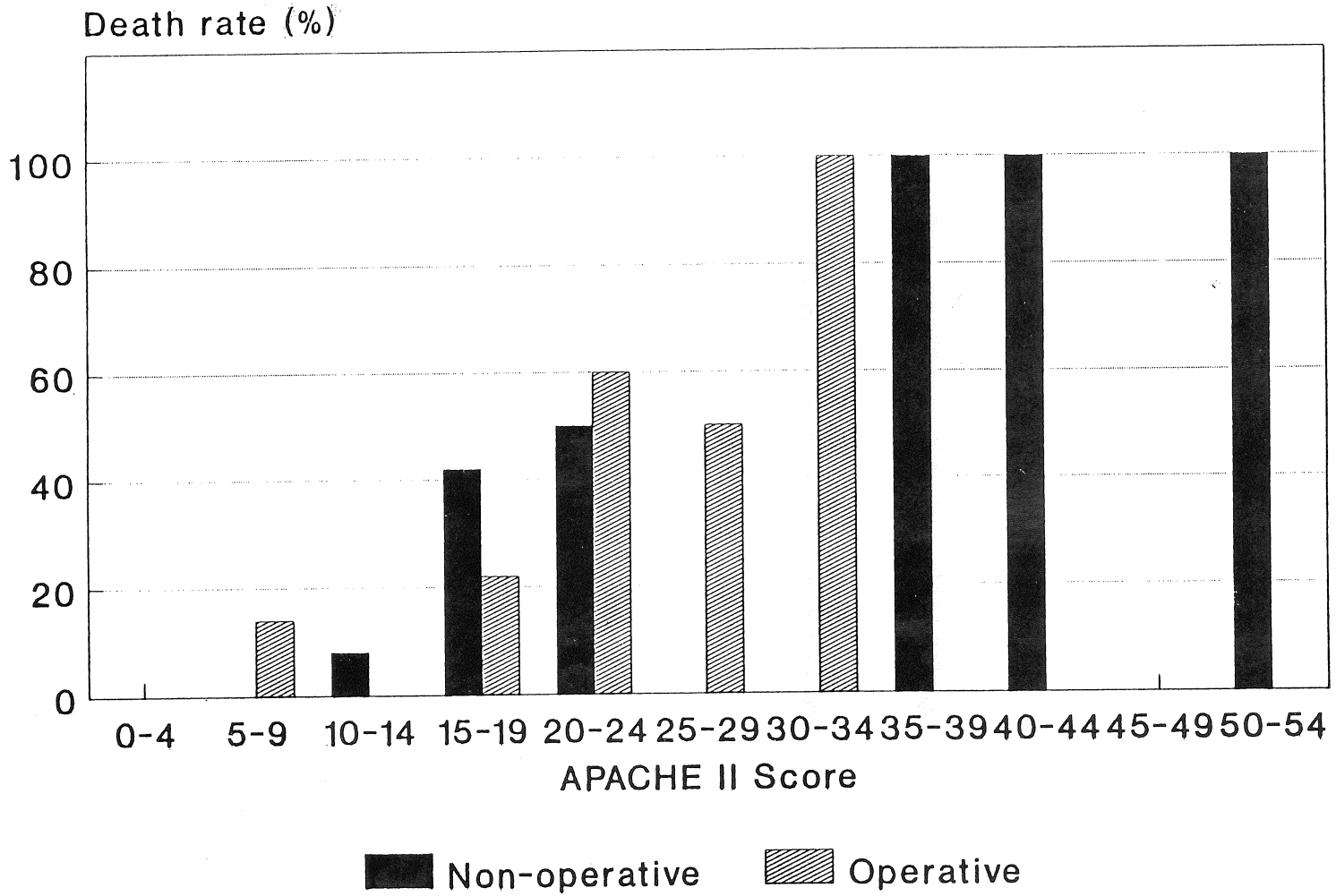

Fig 3. APACHE II scores and hospital mortality in 100 ICU admissions.

Table 3 : APACHE II scores and hospital mortality in 100 ICU admissions

APACHE II Score	Non-operative		Operative	
	Patient	Death	Patient	Death
0 – 4	1	0	8	0
5 – 9	6	0	14	2
10 – 14	12	1	18	0
15 – 19	12	5	9	2
20 – 24	4	2	5	3
25 – 29	2	0	2	1
30 – 34	0	0	1	1
35 – 39	3	3	0	0
40 – 44	2	2	0	0
45 – 49	0	0	0	0
50 – 54	1	1	0	0
Total	**43**	**14**	**57**	**9**

A plot of the death rate against the APACHE II score in non-operative and operative patients is illustrated in Figure 3.

A study of 5815 ICU admissions from 13 hospitals in the United States showed a direct relationship between APACHE II scores and observed hospital death rates as shown in Figure 4[2].

Discussion

The analysis of the spectrum of our ICU admissions indicates that patients with respiratory insufficiency formed the largest proportion of admissions followed by neurological patients. The former included patients with asthma, chronic obstructive pulmonary disease, pulmonary oedema, infection and respiratory insufficiency after surgery. These patients had a good overall prognosis.

The septic patients had higher mortalities as also demonstrated in the study of ICU admissions in the United States[2].

Post cardiac arrest patients generally had a poor outcome in our study. Whether this poor outcome can be attributed to severity of illness such that survival is improbable, or to inappropriate or inadequate ICU treatment needs to be looked into further.

It was noted in our series that longstaying patients may have a low APACHE II score on admission but eventually succumbed. It is perhaps better to do APACHE scoring at frequent intervals so that a better prediction of outcome can be obtained.

The major disadvantages about the APACHE II prognostic scoring system is that the points allocated for the physiologic variables are based on adult values. As such we found that this system was unfortunately not suitable for neonatal cases. Physiologic variables which are abnormal for adults may be normal for neonates.

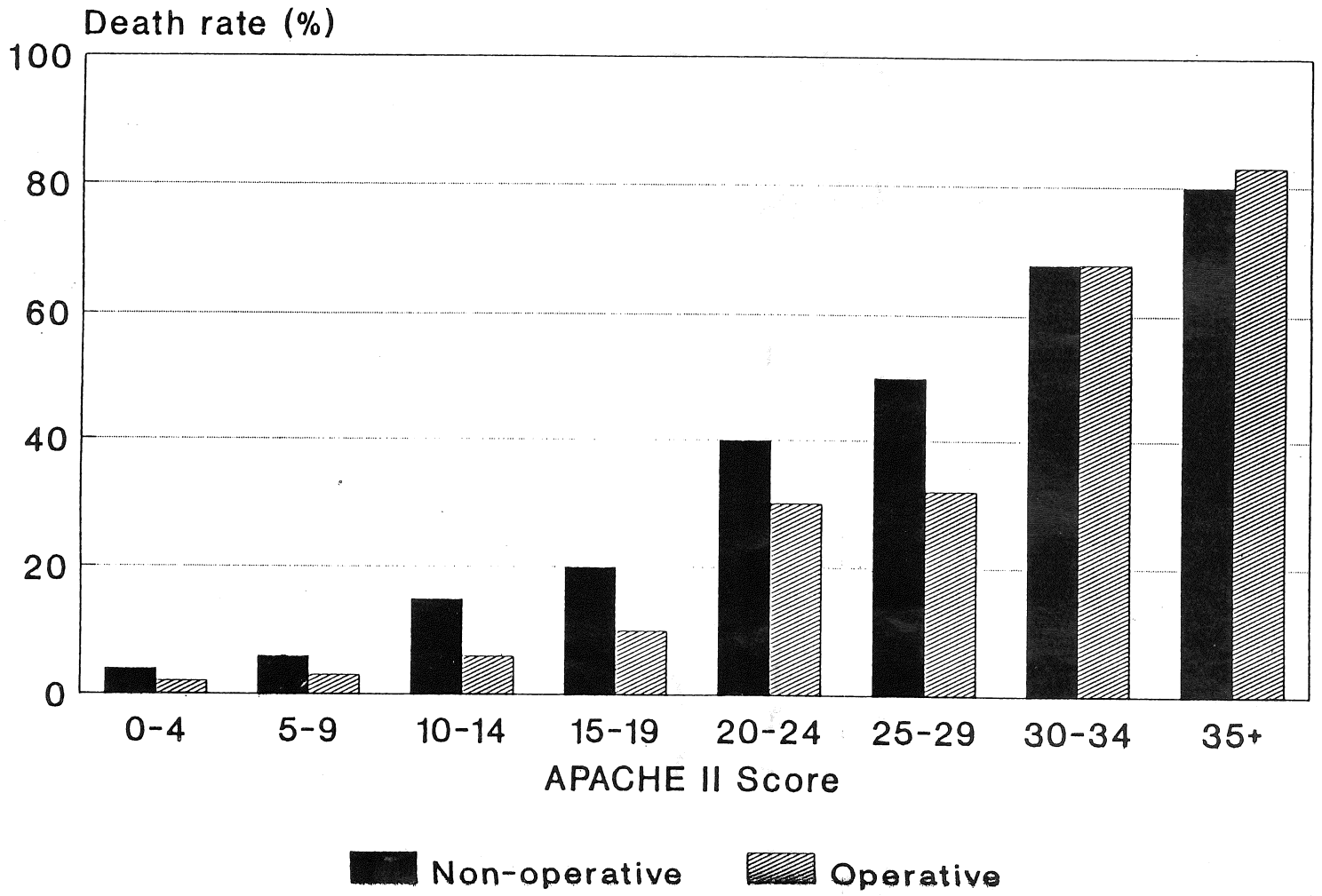

Fig 4. APACHE II scores and hospital mortality in 5815 ICU admissions from 13 hospitals in the U.S.

Another prognostic scoring system known as the Therapeutic Intervention Scoring System (TISS)[5] has been devised by Cullen DJ et al. The main disadvantage of TISS is that it cannot be used to compare results between different hospitals or even among different units in the same hospital. This is because the amount of therapeutic intervention required for each patient is very much dependant on the ability of the physician involved or the policy of the unit. The APACHE II prognostic scoring system overcomes this problem by pre determining the physiologic variables that need to be scored. Thus standardisation of results can be achieved between different hospitals or even within the same unit in each hospital.

We have shown that the APACHE II scoring system can be used in our ICU in Malaysia. We did not encounter much difficulty in implementing the system as most of the physiological variables were already monitored or could be made available to most ICUs.

It would be interesting to evaluate results among ICUs in Malaysia now that there is a fairly accurate and reliable system of comparing the different categories and severity of ICU patients and their final outcome. Self-assessment and proper audit in the ICU in UHKL would also be a possibility with the implementation of such a system.

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References

1. Knaus WA, Zimmerman JE, Wagner DP, Draper EA, Lawrence DE. APACHE – acute physiology and chronic health evaluation: A physiologically based classification system. Critical Care Medicine 1981; 9 : 591 – 597.

2. Knaus WA, Draper EA, Wagner DP, Zimmounman JE. APACHE II. A severity of disease classification system. Critical Care Medicine 1985; 13 : 818 – 829.

3. Sweet SJ, Glenney CU, Fitzgibbons JP, Friedmann P, Teres D. Synergistic effect of acute renal failure and respiratory failure in the surgical intensive care unit. American Journal of Surgery 1981; 141 : 492 – 496.

4. Teres D, Brown RB, Lemeshow S. Mortality of intensive care patients: The importance of coma. Critical Care Medicine 1982; 10 : 86 – 95.

5. Cullen DJ, Civetta JM, Briggs BA. Therapeutic intervention scoring system: a method for quantitative comparison of patient care. Critical Care Medicine 1974; 2 : 57 – 63.