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APACHE-II Score Correlation With Mortality And Length Of Stay In An Intensive Care Unit

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ORIGINAL ARTICLE

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ABSTRACT

Objective: To correlate the APACHE-II score system with mortality and length of stay in ICU.

Study Design: Cohort study.

Place and Duration of Study: The Intensive Care Unit (ICU) of the Aga Khan University Hospital, Karachi, from May 2005 to May 2006.

Methodology: All adult patients who were admitted in the ICU were included. APACHE-II score was calculated at the second and seventh days of admission in the ICU. Patients who were discharged alive from the ICU or died after first APACHE-II Score (at 2nd day) were noted as the primary outcome measurement. Second APACHE-II score (at 7th day) was used to predict the length of stay in the ICU. Pearson's correlation coefficient (r) was determined with significance at $p < 0.05$.

Results: In the lowest score category 3-10, 27 out of 30 patients (90%) were discharged and only 3 (10%) died. Out of those 39 patients whose APACHE-II score was found in high category 31 - 40, 33 (84.6%) deaths were observed. This revealed that there might be more chances of death in case of high APACHE-II score ($p=0.001$). Insignificant but an inverse correlation ($r = -0.084$, $p < 0.183$) was observed between APACHE-II score and length of ICU stay.

Conclusion: The APACHE-II scoring system was found useful for classifying patients according to their disease severity. There was an inverse relationship between the high score and the length of stay as well higher chances of mortality.

Key words: *APACHE-II. Outcome. Mortality. Length of stay. Intensive care unit.*

INTRODUCTION

Due to limited health resources and an increase in the cost of health management, prognosis from the disease has become a very important area of health sciences.[1] Assessment of medical treatment outcome was started in 1863. Florence Nightingale was the first person who addressed this issue.[2] Many scoring systems have been developed for intensive care units. These scoring systems provide gross estimate of mortality risks in intensive care units patients. The most frequently used scoring systems are, APACHE-II (acute physiology and chronic health evaluation II), APACHE-III (acute physiology and chronic health evaluation III), SAPS II (simplified acute physiological score II) and MPM II (mortality probability model II).[3,4]

The APACHE-II and III scoring systems were developed by Knaus *et al.* in 1985 and 1991 respectively.[2,4] The APACHE-II score consists of three components (Table I). Acute physiology score (APS), the largest component of the APACHE-II score is derived from 12 clinical measurements that are obtained within 24 hours after admission to the ICU. The most abnormal measurement is selected to generate the APS component of the APACHE-II score. If variable has not been measured, it is assigned zero points. The variables are, internal temperature, heart rate, mean arterial pressure, respiratory rate, oxygenation, arterial pH, serum sodium, serum potassium, serum creatinin, haematocrit, white blood cells count and Glasgow coma scale. Second component is age adjustment: From one to six points are added for patients older than 44 years of age. Third component of APACHE-II is chronic health evaluation. An additional adjustment is made for patients with severe and chronic organ failure involving the heart, lungs, kidneys, liver and immune system.

One of the limitations of these scoring systems is that these systems basically reflect the population characteristics and the medical culture of the country in which they were originally developed.[5] Same problem exists with APACHE-II. So before the application of these scoring systems they should be tested in the local medical environment. Literature available on this subject in Pakistani context is very limited. This study was designed to correlate the APACHE-II scoring system with mortality and length of stay in patients admitted in intensive care unit.

METHODOLOGY

This study was conducted in a 10-bed, general intensive care unit, at the Aga Khan University Hospital, Karachi, using a multidisciplinary approach to patient care.

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Table I: APACHE-II score and patient's outcome (n=253).

APACHE II score	Number of patients	Patients discharged	Patients died	Observed mortality (%)	Predicted mortality (%)
3-10	30	27	3	10%	11%
11-20	100	71	29	29%	35.5%
21-30	83	33	50	61%	70.3%
31-40	39	6	33	84.6%	91%
> 40	1	0	1	100%	92%

After approval by the institutional Research Ethics Committee, study was prospectively carried out from 10th May 2005 to 10 May 2006. All admitted medical and surgical (non-cardiac) patients aged 12 years or above who remained in the intensive care unit for more than 24 hours, were included in the study. Patients with incomplete set of physiological variables, post - CABG patients and patients who stayed for less than 24 hours in the ICU were excluded. Demographic data, indication of ICU admission and presence or absence of any chronic illness was recorded on a data collection form. At the completion of first 24 hours after the admission in the ICU, APACHE-II score was calculated by using 12 physiological variables. Points were allocated to the worst values of each variable as per protocol of APACHE-II scoring system calculation. Age and chronic health were also assigned points in the similar manner. Sum of A, B and C constituted APACHE-II score for a patient. Glasgow coma scale was used to assess the conscious levels. In post-surgical patients, who were still under the effect of anaesthesia, assessment was made after the patient had overcome the anaesthetic effects. For intubated patients, this score was calculated considering their ability to understand, regardless of speech. Final outcome of the patient (shift out or death) and total length of ICU stay was also recorded. All the data recorded on a proforma of APACHE-II score by the primary investigator.

Statistical analysis was performed through SPSS version-10.0. Numeric response variables including age and length of ICU stay were presented as mean ± SD. All categorical variables including APACHE-II score, age groups and outcome in terms of either death or discharge were presented by frequencies and percentages; chi-square test was applied to compute significance of association of APACHE-II score and age with patients' outcome. Pearson's correlation coefficient was computed to determine correlation of APACHE-II with age and length of hospital stay. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Two hundred and fifty three patients were included in the study; 124 were males and 129 were females. One hundred and thirty five patients had non-surgical indications for ICU admission and 118 had surgical indications for ICU admission. Average age of study patients was 51.26 ± 17.9 (ranging from 15 to 84 years). Eighty nine patients were aged under 45 years. Out of those 89 patients majority (67.4%) survived and were discharged from the ICU. On the other hand, 71 patients aged above 64 years, out of whom 25 (35.2%) survived while 46 (64.8%) died. Significant association (p=0.001) of age with outcome was therefore revealed (Figure 1). Mean APACHE-II score of the study patients was 20.84. On the basis of APACHE-II score, the patients were divided into five groups. The first group patients had APACHE-II score of 3-10, second group had 11-20, third group had 21-30, fourth group had 31-40 and fifth group scored > 40.

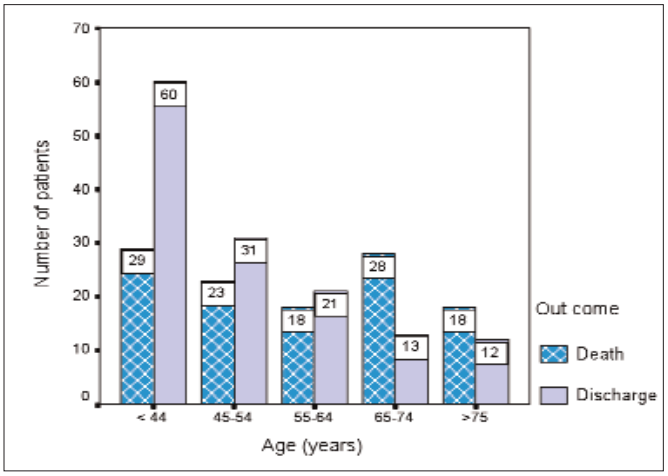

Figure 1: Association of age with outcome (n = 253). Significant association between higher age and expiry of patients (χ^2 = 17.28, p=0.002).

In the first group, there were 30 patients. Out of them, 27 (90%) were discharged and 3 died (10%). There were 100 patients in second group; 71 (71%) were discharged and 29 (29%) died. Eighty three patients were in group III, 33 patients (39%) were discharged, while 50 patients (61%) died. Group IV had 39 patients; 33 (84.6%) died and only 6 (15.4%) survived. There was only one patient in group V, with APACHE II score of > 40, and he died (100%). This revealed that there might be more chances of death in case of high APACHE-II score (p=0.001, and more chances of getting out from the ICU in case of low APACHE scores (Table II, Figure 2). Mean ICU stay in the patients who expired was 6.65 (± 4.76 ranging from 1 to 20) days while in those who survived and discharged was 7.34 (±7.01 ranging from 1 to 51) days. This revealed insignificant difference of mean ICU stay between the expired and alive patients (p = 0.365). Insignificant but an inverse correlation (r = -0.084, p < 0.183) was observed between APACHE-II score and length of ICU stay.

Table II: APACHE-II scoring system.

	+4	-3	-2	-1		+1	-2	+3	-4
Temperature	≥ 41	39-40.9	-	38.5-38.9	36-38.4	34-35.9	32-33.9	30-31.9	≤ 29.9
MAP	≥ 160	130-159	110-129	-	70-109	-	50-69		≤ 49
HR	≥ 180	140-179	110-139	-	70-109	-	55-69	40-54	≤ 39
RR	≥ 50	35-49	-	25-34	12-24	10-11	6-9	-	≤ 5
Oxygenation*	≥ 500	350-499	200-349	-	< 200 P_{a02} >70	61-70	-	55-60	≤ 55
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
Na-	≥ 180	160-179	155-159	150-154	130-149	-	120-129	111-119	≤ 110
K-	≥ 7	6.6-6.9	-	5.5-5.9	3.5-5.4	3-3.4	2.5-2.9	-	≤ 2.5
Creat	-	-	-	-	-	-	-	-	-
Hct	≥ 60	-	50-59.9	46-49.9	30-45.9	-	20-29.9	-	≤ 20
WCC	> 40	-	20-39.9	15-19.9	3-14.9	-	1-2.9	-	.1
15-GCS	-	-	-	-	-	-	-	-	-

** F_1O_2 > 0.5 record oA-aO_2 F_1O_2 < 0.5 record P_{ao2}*
- Plus points for: 1. age > 44 years, 2. chronic health status.

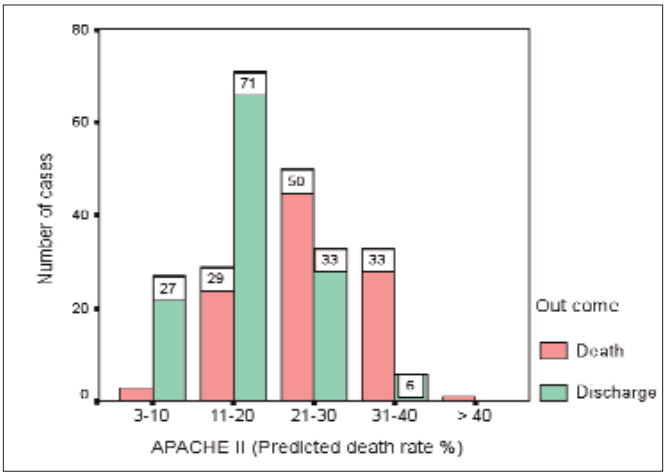

Figure 2: Relationship of APACHE-II score with the outcome of the patients (n = 253).
*Significant relationship between outcome and APACHE-II score (χ^2 = 58.7, p=0.001).

DISCUSSION

Prediction of patient prognosis admitted in intensive care unit always remains an area of great concern for physicians as well as for patient's families. The impact of this prediction bears on different aspects of patient care like selection of medical therapy, triaging, end of life care and many more. The APACHE-II scoring system has been widely accepted as a measure of illness severity. It has been shown to accurately stratify risk of death in a wide range of disease states, and in different clinical settings.[6] In a recently published study, APACHE-II score found more accurate that trauma score to predict mortality in trauma patients as well.[7] Although APACHE-II, mortality probability model II, and simplified acute physiology score II appear to correlate well to different environments, but it is not always true. A multicenter study of 26 British and Irish intensive care units demonstrated the potential limitations of APACHE-II scoring system when applied to a population for which the score has not been validated.[7,8] These limitations arise due to different health care facilities and the variations in the patient population studied. There has been a very limited use of this scoring system in Pakistan. No study was found which addressed the validity of this scoring system in Pakistani population. So it is very important to check its validity in the local population.

Average age of the patients in the current study was 51.26 (±17.9 ranging from 15 to 84) years, which is comparable with 50 (±19 ranging from 13 to 91) years, reported from Brazil, 53 (±19.5) reported from Hong Kong and 56 (±15.9) from Netherland.[9-11] Increasing age is known to be associated with mortality and poor outcome. Mahul and colleagues analyzed the outcome of 295 ICU patients > 70 years of age.[12] They found that age along with previous health status had a predictive value. In the current study significant (p=0.001) association between age with outcome was observed. Patients above 65 years of age not only had a significantly higher (p < 0.01) mean APACHE-II score 19.90 (±8.13) than younger age 12.48 (± 7.00), but also had a higher observed (p < 0.01) and predicted (p > 0.05) mortality.

The patient's distribution in the APACHE-II score intervals showed the highest concentration in the second group (11-30), which is comparable with other studies on this subject. Distribution of patients in first group (3-10) was found significantly low (11.8%) as compared to report from America.[13] Mean APACHE-II score recorded in this study was 20.84, which is similar with mean score of 20 reported from Hong Kong, but higher than 10.7 and 16.5 reported from United States, 16.1 from France, 14.2 from New Zealand and 12.87 reported from India.[9,13,16] These results indicate that the patients were more severely ill at the time of admission in the ICU. One reason of high APACHE-II score observed is the restricted institutional admission policy due to limited ICU beds. The percentage of intensive care unit beds in relation to total number of hospital beds was 1.8%, which is less than other countries, especially the United States of America,[14] where the APACHE-II system was developed. At the time of study by Knaus *et al.*, the percentage of intensive care unit beds in United States of America was 5.6%,[14] and this was increased to 10% by 1992,[15] In Europe this percentage ranged from 2.06% to 3.8%, and in Japan it is 2%.[17]

Overall mortality in this study was 54.2% which is significantly higher than (8.9% to 38.3%) reported from various parts of the world.[13,18-20]

APACHE-II score more than 40 indicates a very high probability of death in the initial 27-72 hours.[6] Results of our study also show a meaningful association between APACHE-II score and the risk of mortality. In each successive APACHE-II score interval the mortality rates were higher than that of the preceding interval. Our findings are comparable with Knaus *et al.*[13] and study from Brazil.[10] These findings confirmed the capability of this scoring system to stratify patients according to the degree of severity of their disease. Our results showed good correlation between observed and predicted mortality. In group 1 patients with APACHE-II score of 3-10, observed mortality was (10%), while predicted mortality was (11%). In next group, APACHE-II score of 11-20, observed mortality was (29%), while expected mortality was (35.50%). Similarly observed mortality was (61%) and (84.6%) in patients with APACHE score 21-30 and 31-40 respectively. Predicted mortality in these groups were (70.3%) and (91%) respectively. These results showed slightly over estimation of mortality risk by APACHE-II scoring system in our population, especially in higher ranges of APACHE-II. Our results contradict the results reported from Brazilian intensive care unit.

ICU length of stay is the most important determinant of ICU cost and resource utilization. In this study, mean ICU stay in the patients who expired was 6.65 (±4.76 ranging from 1 to 20) days while in those who survived and discharged was 7.34 (±7.01 ranging from 1 to 51) days. This revealed insignificant difference of mean ICU stay between expired and alive patients ($p < 0.365$). In a similar study from Hong Kong,[10] the average ICU stay was 4.2 days, which is less than our findings. Insignificant but an inverse correlation ($r=-0.084$, $p < 0.183$) was observed between APACHE-II score and length of ICU stay.

Results of this study showed that, APACHE-II is capable of stratifying patient according to disease severity in relation to mortality. It had good discriminating power for distinguishing patients who survived from those who died. But APACHE-II was not sensitive, specific and accurate enough to predict the patient's exact mortality. Similarly, it was not accurate enough to predict the patient's individual mortality.

CONCLUSION

Results of this study show usefulness of APACHE-II scoring system to classify patients according to their disease severity. The higher the APACHE-II score was, higher the risk of mortality.

Disclosure: This is a dissertation-based article.

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