

## A comparison of APACHE II and APACHE IV scoring systems in predicting outcome in patients with acute lung injury (ALI) and the adult respiratory distress syndrome (ARDS) in intensive care unit (ICU)

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**Objective:** To compare APACHE IV and APACHE II scoring methods for patients admitted in an ICU with ALI and ARDS.

**Methodology:** This comparative study was conducted in ICU Lady Reading Hospital, Peshawar, Pakistan from June 2011 to November 2012. All cases of ALI/ARDS were included in the study. Observed mortality rates were compared with predicted mortality rates for both the APACHE IV and APACHE II scoring systems, standardized mortality ratio (SMR) and sensitivity and specificity were determined. The mortality percentages were predicted via APACHE IV method and compared with the observed data. Data were analyzed with SPSS vs. 16.

**Results:** There were 47 patients in the study. Mean age for males was  $35 \pm 16.82$ , while  $34 \pm 17.35$  years for females. The overall mortality observed was 32% (15/47). APACHE IV predicted

mortality rate sensitivity and specificity were 94.73% and 93.74% respectively, SMR of 0.94 and diagnostic value was 93.62%. APACHE II predicted mortality sensitivity and specificity were 100% and 87%, SMR of 0.79 and diagnostic value was 91%.

**Conclusion:** APACHE IV scoring system is equally sophisticated as the APACHE II system in predicting mortality rate in ICU patients with ALI/ARDS. APACHE IV score (score > 90) gives probably additional reliable prediction of high possibility of death in patients with ALI/ARDS than APACHE II (score > 25). Supplementary comprehensive research work is needed in excellence of our conclusion with matching ICUs and distinct diseases. (Rawal Med J 2013;38:234-238).

**Key words:** ALI, ARDS, ICU, APACHE scoring system.

### INTRODUCTION

The mortality rate from Acute Lung Injury (ALI) and the Acute Respiratory Distress Syndrome (ARDS) is 40-50%.<sup>1</sup> Conventional approaches to mechanical ventilation make use of tidal volumes of 10 to 15 ml per kilogram of body weight.<sup>2</sup> In patients with ALI/ARDS, mechanical ventilation with lower tidal volumes (7 to 8 ml per kilogram) than is traditionally used results in reduced mortality and raises the total number of days without to make use of ventilator.<sup>3</sup> ALI and ARDS have a poor prognosis despite intensive care treatment.<sup>4</sup> A precise prediction of length of stay (LOS) of ALI/ARDS patient's in ICUs is decisive to ICU outcome measurement, its resource management and floor management. Insufficient provision of resources for critically ill patients may result in too much intensive care mortality that is not identified with

ICU outcome prediction techniques.<sup>5</sup> APACHE II has been used worldwide for measuring ICU Performance.<sup>6</sup> The system, outlined by Keegan et al<sup>7</sup> has been authenticated in several clinical trials, and is universally used severity of illness evaluation. APACHE II estimates risk, based on data accessible within first 24 hours of ICU stay. APACHE IV is the most modern standardized metrics to evaluate the severity of ill health and prognosis in the ICU.<sup>7</sup> Additionally, scores may serve the purposes of evaluating treatments, quality control and quality guarantee, and economic evaluation of intensive care. This was carried out for the first time in Pakistan to compare the performance of the APACHE II and APACHE IV scoring methods in predicting outcome of patients admitted in an ICU with ALI and ARDS.

## METHODOLOGY

This comparative prospective cohort study was carried out at ICU of Lady Reading Hospital, Peshawar, Pakistan from June 2011 to November 2012. Ethical Approval was obtained from the Institutional Research and Ethics Board, Lady Reading Hospital, before starting the study and informed written consent was taken from each patient or their first degree relative.

A total of 47 patients were included in the study who were intubated and were receiving mechanical ventilation. They had an acute decrease in the ratio of partial pressure of arterial oxygen to fraction of inspired oxygen 300 or less (indicating the onset of hypoxemia; values were adjusted accordingly), bilateral pulmonary infiltrates on a chest radiograph consistent with the presence of edema, and no clinical evidence of left atrial hypertension or (if measured) a pulmonary-capillary wedge pressure of 18 or less. 1 Patients were excluded if 36 hours had elapsed since they met the first three criteria, they were younger than 15 years and older than 60, they had taken part in further trials within 30 days before the first three criteria were met, they were pregnant, they had increased intracranial pressure, neuromuscular diseases that could impair natural breathing, sickle cell disease or severe chronic respiratory diseases, they weighed more than 1 Kg Per Centimeter of Height, they had burns over more than 30% of their body-surface area, they had undergone bone marrow or lung transplantation, they had chronic liver diseases (Child-Pugh Class C), or their attending physician turned down or was unwilling to have the same opinion to use of full life support.

The day after ICU admission, the worst values on APACHE IV and APACHE II variables were abstracted from clinical and laboratory records and APACHE Scores were calculated using an online APACHE score calculators. Observed mortality rates were compared with predicted mortality rates for both the scoring systems and standardized mortality ratio (SMR) and sensitivity, and specificity were determined. APACHE IV ICU-Length of Stay (LOS) of patients was compared with observed ICU-LOS and days on mechanical

ventilation.

Statistical analysis was done via SPSS vs. 16 and  $P < 0.05$  was considered significant. First of all it was tested for standard distribution with the Kolmogorov-Smirnov test (K-S) test. Discrepancies between studies groups were evaluated by means of the Mann Whitney U test; the Wilcoxon signed-rank test was used for the paired comparisons of abnormal distribution variables into the groups. Chi Square test was applied to compare the qualitative variables. Receiver Operating Characteristics (ROC) curve was used and area beneath the ROC curve was calculated to test bias. The Standardized Mortality Ratio (SMR) with 95% confidence intervals was calculated and the dissimilarity between Observed and Predicted numbers of ICUs death were also analyzed.

## RESULTS

Demographic characteristics of study population are summarized in Table 1. Out of 47 patients, 19 (40.43%) had ALI/ARDS of unknown cause and 28 (59.57%) had ALI/ARDS of known cause. Out of 19 patients, who had ALI/ARDS of unknown etiology, 10 (52.63%) died, while in the remaining 28 patients who had ALI/ARDS of known causative agents, 5 (17.85) died.

**Table 1: Demographic characteristics of patients (n=47).**

Gender	Non-survivors		Survivors		p value
	n	%	n	%	
Female	7	46.66%	9	28.1%	0.127
Male	8	53.33%	23	71.8%	
Total	15	100%	32	100%	
Age (in years)	Mean±SD	Range	Mean±SD	Range	0.000
	47.92	40-55	28.86	20-35	

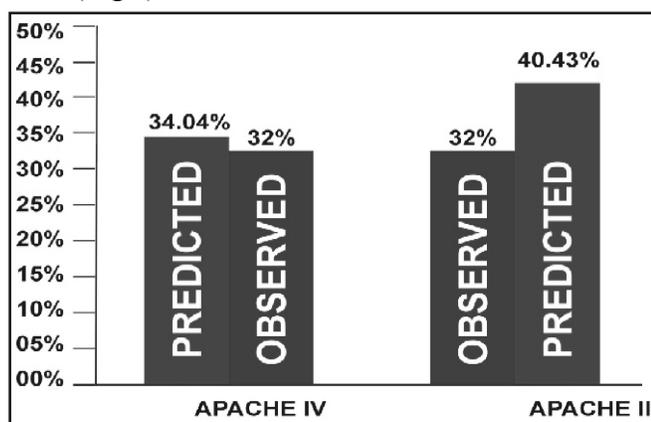
The overall mortality was 32% in all the patients (15 died out of 47;  $P < 0.01$ ). Mean observe ICU-LOS in days was 15+06.5 for non-survivors, and 12+5.2 for survivors group, which was appreciably greater than the APACHE IV predicted ICU-LOS in days. Length of ventilation time in days for non-survivors in ICU was 14+6.5, and for survivors it was 10+2 ( $P < 0.05$ ). Comparison of non survivors and survivors scoring systems of every patient are shown in Table 2.

**Table 2: Comparison of non survivors and survivors scoring systems (n=47).**

	Non-survivors			Survivors			P Value
	N	Mean±SD	Range	N	Mean±SD	Range	
<b>APS score</b>	15	88.8±13.7	75-110	32	67.1±9.6	46-92	0.000
<b>AP II score</b>	15	28.8±3.7	26-46	32	22.4±3.1	16-28	0.000
<b>AP II Pred.</b>	*	*	*	*	*	*	*
<b>M.RATE</b>	15	0.66±0.21	0.54-0.92	32	0.42±1.0	0.20-0.61	0.000
<b>AP IV score</b>	15	106.4±2.9	86-138	32	78.9±12.6	51-105	0.000
<b>AP IV Pred.</b>	*	*	*	*	*	*	*
<b>M.RATE</b>	15	0.66±0.12	0.52-0.88	32	0.38±0.11	0.18-0.51	0.000

**APACHE IV AND APACHE II** scores were significantly elevated in non-survivors groups (**p=0.000**). **APS** score=Acute Physiology Score\* APS is derived from APACHE-IV. **AP II** = Acute Physiology and Chronic Health Evaluation II. **AP IV** = Acute Physiology and Chronic Health Evaluation IV. **Pred. M. Rate** = Predicted Mortality Rate

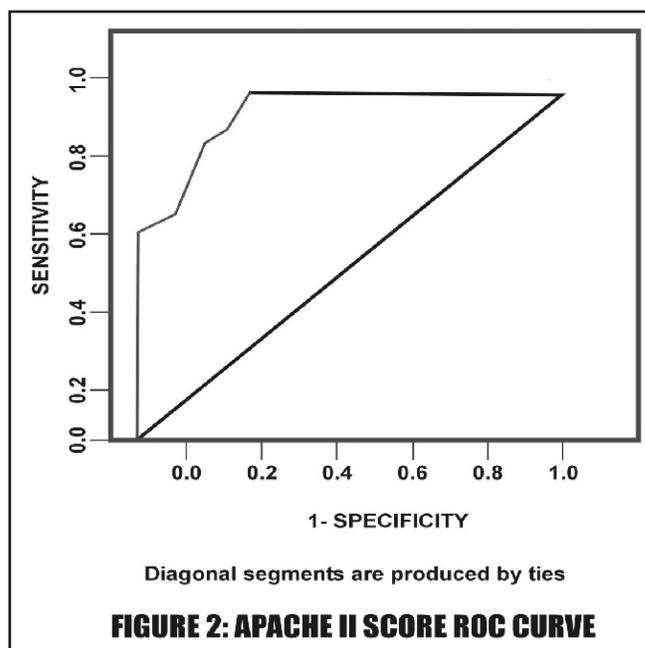
The Mean APACHE IV score was 90±11.6, sensitivity was 94.73%, specificity was 93.74%, and diagnostic value was 93.62% and SMR was 0.94. APACHE IV Predicted deaths were 34.04%. Mean APACHE II score was 25.7±4.3, sensitivity was 100%, specificity was 87, and diagnostic value was 91% and SMR was 0.79. APACHE II predicted deaths were 40.43%. Observed Mortality Rate was 32% (Fig 1).



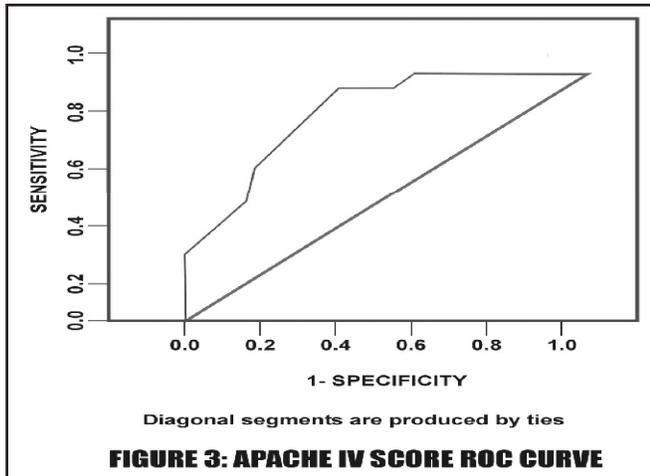
**FIGURE 1: Comparison of observed versus Predicted Mortality Rates.**

The area under ROC curve was 92% for APACHE IV and 97% for APACHE II. The predictability of APACHE II was more sensitive than APACHE IV, but APACHE IV predictions were more selector and more reliable than APACHE II. The distinction of

non-survivors situation was 92% for APACHE IV and 97% for APACHE II (Figs 2, 3).



Acute Physiology Score (APS) was a derivative of APACHE IV. **Mean APS score was 77.8 (±11.8)**. APACHE IV, APS and APACHE II scores were significantly different among survivors and non-survivors groups (**P=0.000**). All scores were drastically higher in non-survivors.



## DISCUSSION

The results from our study have established that the APACHE IV prognostic scoring system predicted death rate better than APACHE II scoring method. The results of this study is as good as to the results of the study done by **Lieberman et al**<sup>8</sup> as they had taken APACHE IV scoring system for outcomes of patients evaluation and taken a variety of parameters like physiological variable, vital signs, urine output, neurological score, beside the age related parameters and comorbid conditions. In contrast to our study, **Lieberman et al**<sup>8</sup> had used APACHE IV scoring method for measuring ICU performance on stroke's patients. The results of our study are analogous to the study carried out by Ayazoglu TA,<sup>9</sup> which clearly demonstrated that APACHE IV scoring method was superior to the APACHE II. The only difference is that patients included in our study were ALI and ARDS as compared to the above study done by Ayazoglu TA<sup>9</sup> which had also included patients with stroke.

A local study from Karachi by Yamin et al<sup>10</sup> clearly demonstrated that APACHE IV can be used in predicting mortality among every patient, because it gives an idea about good prediction of mortality among every ICU patients. They also showed that APACHE IV was an excellent prediction for duration of stay and death at ICU in the surgical patients.<sup>10</sup> In contrary to study by Karen et al,<sup>11</sup> our study did not confirm any correlation between the patients' age and disease severity, though the age of non-survivors was seen to be more than survivors. Fresh therapies in the development for treatment of

ALI/ARDS consist of exogenous surfactant, therapies designed at modulating neutrophil action, such as prostaglandin and complement inhibitors, and treatment targeted earlier resolution of ARDS, such as beta agonists and granulocyte macrophage colony-stimulating factor. Inhaled Prostaglandin E1 has been used to improve hypoxia without mechanical ventilation.<sup>12,13</sup> Another study reported overall mortality due to all causes of 34% and this increase in mortality was related to pneumothorax secondary to mechanical ventilation and other air leaks.<sup>14</sup> In this study, the total mortality observed was 32%. A study by Salahuddin et al<sup>12</sup> reported that those patients who develop ARDS due to pulmonary tuberculosis, have a different preponderance of Mycobacterium strains compared to those who do not develop ARDS in pulmonary tuberculosis. **Bhattachayya et al** has recommended APACHE IV might be more relevant to estimate ICU performance.<sup>15</sup> Use of eCare to track 94% of the patients allows economy of scale resources utilization and less need for costly hand review.<sup>16</sup> APACHE IV is not trustworthy tool to predict death and duration of stay in patients with sepsis and acute pancreatitis.<sup>17</sup> In opposing to a study carried out on APACHE IV in pancreatitis patients the predicted and observed duration of stay and mortality were pretty different.<sup>18</sup> However, there is still need for further research on APACHE IV with contrasting ICU and contrasting diseases.

## CONCLUSION

APACHE IV (score>90) was more reliable predictor of high risk of death in patient with Acute Lung Injury/Acute Respiratory Distress Syndrome than APACHE II (score>25). APACHE IV score is a valid method of predicting outcome in ALI/ARDS patients.

### Author contributions:

Conception and design: Mustafa Kamal  
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 Critical revision of the article for important intellectual content: Gauhar Ali  
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**Conflict of Interest:** None declared  
 Rec. Date: Feb 22, 2013 Accept Date: May 13, 2013 06:30

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