

COMPARISON OF APACHE II AND GCS IN PREDICTING MORTALITY AND MORBIDITY IN HEAD TRAUMA PATIENTS IN CRITICAL CARE UNIT

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Abstract

Background: The objective is to validate the accuracy of GCS and APACHE II for the prediction of functional outcome and mortality in head trauma patients admitted in critical care unit. **Materials and Methods:** The present study was carried out in critical care unit of tertiary care institute on 70 consecutive patients of either sex admitted with head injury with interventions and without interventions. After admission detail history of all the patients were taken and their clinical assessment were done. Vitals of the patients were monitored by attaching NIBP, IBP, SPO₂, and ECG. Blood sample were collected at time of admission for routine investigations and arterial blood gas analysis. GCS and APACHE II scoring were measured on day of admission and were tabulated. The mortality and survival of all the patients during 7 day period was noted and tabulated. **Result:** The study was conducted on 70 consecutive patients with head trauma admitted to CCU during January 2015 to May 2016 with mean age 49.9yrs and M: F of 26:9, and mean length of stay in CCU was 3 days. The mean APACHE II score was 25.67 and mean GCS score was 11.01. The sensitivity, specificity, and accuracy for APACHE II was 62.5%, 71.7% and 68.5% respectively. The sensitivity, specificity and accuracy for GCS was 37.5%, 97.8% and 77.14% respectively. The 7th day outcome score for APACHE II in patients who died was 21.19+/- 5.41 and in patients who survived was 16.51+/- 4.42. For GCS 7th day outcome score for patients who died was 8.13+/- 1.91 and for patients who survived was 12.49+/- 1.97. The area under ROC curve for APACHE II was 0.755 and for GCS was 0.948. **Conclusion:** The present study concluded that GCS as well as APACHE II both are comparable in predicting outcome in head injury patients. GCS is simple, less time consuming and more accurate for predicting early outcome than APACHE II. But for prediction of late mortality, the APACHE II has better accuracy than GCS.

INTRODUCTION

The care of critically ill patients has advanced tremendously in the past four decades due to the clinical acumen of the critical care provider. The clinical situation of patients themselves renders correct prognosis fundamentally important not only for patients, their families & physicians but also for hospital administrators, fund providers & controllers. The outcome of critically ill patients can now be predicted and evaluated using well planned severity of illness scoring systems.^[1,2]

There are numerous prehospital descriptive scoring systems and it is uncertain whether they are efficient in assessing severity of illness and whether they have a prognostic role in the estimation of outcome. There

are five major purposes of severity-of-illness scoring systems.^[3,4]

1. To quantify severity of illness for hospital and health care system administrative decisions such as resource allocation
2. To assess the prognosis of individual patients to assist families and caregivers in making decisions about ICU care.
3. To assess ICU performance and compare the quality of care of different ICUs and within the same ICU over time. Severity-of illness scoring systems could be used to assess the impact on patient outcomes of planned changes in the ICU, such as changes in bed number, staffing ratios, and medical coverage.

4. Scoring systems have been used in randomized controlled trials (RCT) and other clinical investigations.
5. Finally, scoring systems are now being used to evaluate suitability of patients for novel therapy (e.g., the use of the APACHE II assessment for prescription of recombinant human activated protein C.

Initially, clinical, and physiologic variable selection was based on subjective judgment of clinicians, review of the literature, and development of consensus. Subsequently, logistic regression modeling techniques were used to select predictive variables from a derivation data set. Ideal variables are simple, well-defined, reproducible, and widely available measurements or data that are collected routinely during patient care. Many clinical and physiologic variables were collected on many patients, and their survival statuses at ICU and hospital discharge were recorded. Multiple logistical regressions identify the specific variables that best predicted survival and assigns relative weights to each variable. This set of variables is then tested prospectively for accuracy of prediction in another sample of patients to validate the selection process and appropriate weighing of variables. The growing focus on health quality and mortality risk increases the need for accurate severity scoring systems in patients. With accurate severity scales we can compare clinical outcomes.^[5,6]

Glasgow coma scale (GCS) is popular simple and reliable and provides good information about the level of consciousness in trauma patients along with other neurological assessment. The basis for Acute Physiological and Chronic Health Evaluation score (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. APACHE was developed in 1981 to measure disease severity. APACHE II was implied modification of original APACHE, which consist of 12 acute physiological variables, age and chronic health status.^[7,8]

This study compares the efficacy of predicting power for mortality and functional outcome of GCS and APACHE II in patients with traumatic head injury in CCU.

MATERIALS AND METHODS

The present study was carried out in critical care unit of tertiary care institute on 70 consecutive patients of

either sex admitted with head injury with interventions and without interventions from January 2015 to August 2016. Written informed consent was obtained from relatives or from patients included.

After admission detail history of all the patients were taken and their clinical assessment were done. Vitals of the patients were monitored by attaching NIBP, IBP, SPO2, and ECG. Blood sample were collected at time of admission for routine investigations and arterial blood gas analysis.

Inclusion criteria of Patients

- Age above 14yrs
- Traumatic head injury / Multiple trauma cases with intervention or without intervention
- Patients admitted within 24hrs of injury
- Patients admitted in critical care unit and under observation for 1 week.

Exclusion criteria of Patients

- Transfer in patients from other institute or from general ward
- Drug and alcohol intoxication
- Other causes of unconsciousness like low oxygen, shock, hypoglycemia and others.
- Patients remaining more than 1 week in critical care unit.

Scoring Systems

- GCS: It was measured on day of admission and were tabulated.
- APACHE II scoring: It was measured on day of admission and were tabulated.

The mortality and survival of all the patients during 7day period was noted and tabulated.

RESULTS

In this study 70 consecutive patients were included in which 18 were females and 52 were males. Mortality among females were 27% and among males were 36%. The mean age was 49.9+/- 1.29 with age variation between 14yrs to 72 yrs.

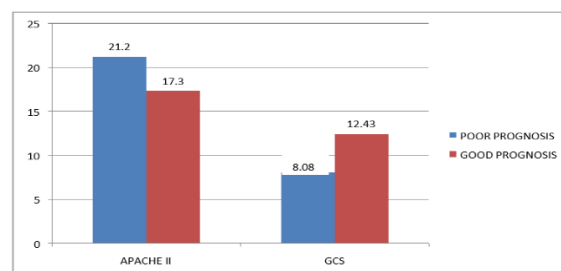


Figure 1: Relation between APACHEII & GCS and outcome

Table 1: Demographic Data.

Mean age	49.9yr
Male: female	52:18
Mean length of stay in CCU	3 days
Mean APACHEII	25.67
Mean GCS	11.01

Table 2: Relation Between GCS Score and Outcome

GCS	Mean	SD	Min	Max	P value
Poor prognosis	8.08	1.81	3	10	
Good prognosis	12.43	2.06	3	14	0.001

This table shows relation between the outcome and GCS score. The mean GCS in poor prognosis was 8.08+/- 1.81; while in good prognosis were 12.43+/-

2.06. There was statistically significant increase in GCS in good prognosis patients than the poor prognosis (p=0.001).

Table 3: Relation Between Apacheii Score and Outcome

APACHEII	mean	SD	Min	max	P value
Poor prognosis	21.2	5.91	11	36	
Good prognosis	17.3	5.18	3	29	0.001

This table shows relation between the outcome and APACHEII score. It was observed that, the mean value of APACHEII score in poor prognosis was 21.2+/-5.91; while in good prognosis were 17.3+/-

5.18. There was statistically significant increase in APACHEII score in poor prognosis than good prognosis (p=0.001).

Table 4: Association of GCS And Its Outcome Within The Group

GCS		Death	Survival	Total
<8	No.	9	1	10
	%	37.5%	2.2%	14.3%
8 & above	No.	15	45	60
	%	62.5%	97.8%	85.7%
Total	No.	24	46	70
	%	100%	100%	100%

This table shows that mortality and survival rate in GCS score below 8 was less i.e. 2.2% than the survival rate in score more than 8 i.e. 97.8% which

was statistically significant. As the score decreases mortality increases.

Table 5: Association of Apacheii Score and Its Outcome Within the Group

APACHEII		Death	Survival	Total
20 & above	No.	15	13	28
	%	62.5%	28.3%	40.0%
<20	No.	9	33	42
	%	37.5%	71.7%	60%
Total	No.	24	46	70
	%	100%	100%	100%

This table shows that the mortality and survival rate in APACHEII score when cut off of 20 was applied. In APACHEII score below 20 the mortality rate was 37.5% and survival rate was 71.7%. In APACHEII

score ≥ 20 the mortality rate was 62.5% and the survival rate was 28.3%. As the score increases the mortality increases.

Table 6: Comparison Between Two Scores And 7-Day Mortality

	MOD outcome	No.	Mean	Std. Deviation	Unpaired t test	P value
APACHE II	died	24	21.19	5.41	3.892	0.000
	survived	46	16.51	4.42	Difference is significant	
GCS	died	24	8.13	1.91	-8.903	0.000
	survived	46	12.49	1.97	Difference is significant	

The mean value for APACHE II score during span of seven days mortality group was 21.19+/- 5.41, which is significantly higher than the mean APACHE II value for survival group i.e. 16.71+/- 4.42.(p=0.000). The mean value for GCS score during span of seven

days for mortality group was 8.13+/-1.91, which is statistically significantly lower than the mean value of GCS score for survival group i.e. 12.43 +/- 1.97.(p=0.000).

Table 7: Comparison Between Two Scoring Systems

	Sensitivity	Specificity	Accuracy
APACHEII	62.5%	71.7%	68.5%
GCS	37.5%	97.8%	77.14%

This table shows that sensitivity of APACHEII score is higher i.e. 62.55% than GCS score i.e. 37.5%. The specificity of APACHEII score is 71.7% which is lower than GCS specificity i.e. 97.8%. The accuracy of GCS is 77.14% and the accuracy of APACHEII is 68.5%.

The study was conducted on 70 consecutive patients with head trauma admitted to CCU during January 2015 to May 2016 with mean age 49.9yrs and M:F of 26:9, and mean length of stay in CCU was 3 days. The mean APACHEII score was 25.67 and mean GCS score was 11.01. The sensitivity, specificity and accuracy for APACHEII was 62.5%, 71.7% and 68.5% respectively. The sensitivity, specificity and accuracy for GCS was 37.5%, 97.8% and 77.14% respectively. The 7th day outcome score for APACHEII in patients who died was 21.19+/- 5.41 and in patients who survived was 16.51+/- 4.42. For GCS 7th day outcome score for patients who died was 8.13+/- 1.91 and for patients who survived was 12.49+/- 1.97. The area under ROC curve for APACHEII was 0.755 and for GCS was 0.948

Statistical Analysis

- The data was collected in Microsoft excel spreadsheet and it was analyzed statistically by deriving mean and standard deviation and ratio wherever necessary.
- The statistical analysis was put in tabular form and represented by various graphs i.e. bar diagram for comparison of variables between the groups and within the groups. All statistical analysis was done using SPSS 20.
- For detail analysis Chi-square test, student t test, ANOVA, repeated measure ANOVA, Youden index, Hosmer Lemeshow statistics test and logistic regression analysis was used to calculate p value.
- A p value < 0.05 was considered statistically significant, p value < 0.001 was considered highly significant and p value > 0.05 was considered insignificant. AUC > 0.7 is considered statistically significant.

DISCUSSION

In the present study the two physiological scores i.e. APACHE II and GCS were compared. The aspects of comparison were functional outcome within the scores along with sensitivity, specificity, and accuracy. In the present study 70 consecutive head trauma patients with intervention and without intervention admitted to CCU (critical care unit) from January 2015 to May 2016 were taken. Patient's age group was 14 to 72 yrs with mean age of 49.9yrs, and male: female ratio of 26:9. The mean length of stay of these patients in CCU was 3 days with mean GCS score 11.01 and mean APACHE II score of 25.67.^[9] The GCS is a physiological scoring system and it remains a critical measure of neurological assessment and assessment of severity of traumatic brain injury (TBI) on admission. Its correlation with morbidity

and mortality was approved by many authors in last 3 decades. It is acknowledged that low GCS is associated with poor prognosis; however the measurement can be complicated when it is low. This scale measurement can be difficult to assess when patient is on ventilator or sedated. There seem to be similar problems for prediction of score in resuscitated patients. Pharmacological neuromuscular blockage used for intubation further complicates clinical assessment with this scale.^[10,11]

Scores and Their Outcome: In the present study it was observed that the mean GCS score in patients who died was 8.08+/-1.81 and mean GCS score in patients who survived was 12.43+/-2.06. Patients with GCS score <8 had mortality rate 37.5% which is significantly higher than patients with GCS score >=8.^[12,13]

GCS score has been incorporated into various outcome prediction models including Trauma score, RTS, APACHE II and APACHE III and TRISS. Bastos PG et al in 1993 studied the ability of GCS score to predict hospital mortality rate. In this study he observed that low GCS score was associated with poor outcome. Balestrei M et al in 2004 studied the predictive value of GCS for outcome in TBI patients. He found significant positive correlation between GCS score and outcome. Similar study was conducted by Davis DP et al in 2006 who studied the predictive value of field vs arrival GCS score in predicting outcome. He observed that mean value of field GCS and arrival GCS was similar (11.4 & 11.5 respectively, p=0.336) and a strong correlation (r=0.67) was observed between them. The field GCS was statistically significant in determining the arrival GCS and outcome. Above studies correlate with the present study and showed that GCS score is statistically significant in predicting hospital outcome.^[14,15]

In 2013 Zhao XX et al studied the performance of SAPS and GCS in predicting outcome in neurosurgical CCU. The cutoff value was 33 (sensitivity of 85.2% and specificity of 74.3%) for SAPS (simplified acute physiology score) and 6 (sensitivity of 70.6% and specificity of 65%) for GCS respectively. SAPS at each point of time on all patients served better calibration, consistency, and discrimination than GCS. This study does not correlate with the present study. Systemic hypotension, intracranial hypertension, arterial hypoxia and hypocapnia are well known physiological factors associated with poor outcome after TBI.^[16,17]

Severity of Coma due to head trauma could be assessed mainly by GCS; however the prognosis could also be influenced by many factors like age, previous health state, hypoxemia, hypotension, hyponatremia, anemia, and previous CPR and coagulation disorders. Considering these facts APACHE score was developed in 1981. The basis for the development of APACHE depends on the hypothesis that the severity of acute disease can be measured by quantifying the degree of abnormality

from multiple physiological variables. It covers GCS, age and chronic health status, which are thought to reflect physiological reserve. Pathophysiological changes predicted after trauma could be demonstrated easily by APACHE II scoring system.^[18,19]

In the present study, the mean APACHE II score for poor outcome was 21.2±5.91 and for good outcome was 17.3±5.18 and the mortality rate for APACHE II score ≥ 20 was found to be 62.5% which was higher than for APACHE II score < 20 . Similar study was done by Rowan KM et al in 1994 to compare the ability of two methods i.e. APACHE II and MPM (mortality probability model) to predict hospital outcome for a large group of CCU patients. The observed and predicted risks of hospital mortality were 81 and 57 for APACHE II and area under roc curve was 0.83 for APACHE II, which showed that APACHE II score was better than MPM in predicting outcome.^[20]

In 1995 Wong DT et al evaluated the ability of APACHE II scoring system to predict outcome in Canadian CCU. The predicted risk of death was calculated for each patient using the APACHE II risk of death equation. The mean APACHE II score was 16.5±0.2. The predicted death rate was 24.7% and observed rate was 24.8% which were comparable. Similarly in 2006 Ho KM et al did a comparison of admission and worst 24hr APACHE II scores in predicting mortality. The mean admission and worst 24hr APACHE II score were 12.7 and 15.4. The predicted mortality was 15.5% and 19.3% respectively. Actual hospital mortality was 16.3%, which were comparable. Above studies and the present study concluded that APACHE II was statistically significant in predicting hospital outcome.

Comparison Between Two Scores: In this study it was observed that for APACHE II sensitivity was 62.5%, specificity was 71.7% and accuracy was 68.5%. Similarly for GCS sensitivity was 37.5%, specificity was 97.8% and accuracy was 77.14%. Many studies were conducted using similar statistical method. In 1997 Cho DY et al compared the APACHE III, APACHE II and GCS in acute head injury for prediction of mortality and functional outcome. The sensitivity for APACHE III was found to be 82.4%, for APACHE II was 78.4% and for GCS was 81.9%. Area under ROC curve was 0.90 in APACHE III, 0.84 for APACHE II and 0.86 in GCS. It concluded that APACHE III is better in predicting outcome in head injury patients followed by GCS and then APACHE II.

In 1998 Alvarez M et al did a study to assess the performance of general severity systems (i.e. APACHE II, SAPS & MPM) for head trauma patients and to compare these systems with GCS, to obtain a good estimate of severity of illness and probability of hospital mortality. The area under ROC curve was found to be 0.95 for SAPS, 0.94 for APACHE II and 0.90 for MPM. This study concluded that MPM performs better than rest for

head trauma patients. In this study it was observed that area under ROC curve was 0.75 for APACHE II & 0.94 for GCS. This study concluded that MPM was better in predicting outcome followed by GCS and then APACHE II. In 2001 Grmec S et al studied the comparison of APACHE II, MEES and GCS in patients with non-traumatic coma for prediction of mortality. They studied 286 patients and post intervention values of APACHE II, MEES and GCS were measured. The best cutoff points were 19 for APACHE II, 18 for MEES and 5 for GCS. The correct prediction of outcome was achieved in 79.9% for APACHE II, 78.3% for MEES and 81.9% for GCS. The area ROC was 0.86 for APACHE II, 0.84 for MEES and 0.88 for GCS. He concluded that APACHE II is not better than GCS and MEES for prehospital descriptive scoring systems.

In above studies it was observed that APACHE II and GCS are comparable in predicting hospital outcome in traumatic brain injury (TBI). In the present study it was observed that GCS is more accurate in calculating the outcome i.e. probability of death in head trauma patients.

Comparison Between Two Scores and 7th Day Mortality: In this study the mean APACHE II score for survival group during span of 7 days was 16.51±4.42, and for GCS was 12.49±1.97, which is lower than APACHE II score for survival group. Naved S. Ahmed et al in 2011 studied the APACHE II score correlation with mortality and length of stay in an CCU. This study revealed that there might be more chances of death in case of high APACHE II score ($p=0.001$). Insignificant but inverse correlation ($r=0.0084$, $p<0.183$) was observed between APACHE II score and length of stay. Similar study was done by Okasha et al in 2011 to compare the validity of 6 scoring systems i.e. GCS, APACHE II, RTS, ISS, TRISS and TISS in predicting outcome in critically ill polytraumatized patients. Pt outcome at 1 month was assessed by Glasgow outcome score. Correlation of the outcome with different individual score results and comparison between different individual scores were done. It was found that all 6 scores correlate significantly with the outcome parameters with different degree of significance.

For the assessment of early mortality, GCS score still provides simple, less time consuming & effective information concerning head injury patients, especially in an emergency. Although GCS provides a quick assessment of severity of illness in head trauma patients, an accurate evaluation score could be obtained by APACHE II scoring system. Both systems provide clear estimates about the risk of hospital mortality. Both scoring systems were found to have statistically comparable accuracy in predicting hospital mortality. When GCS & APACHE II systems were evaluated the area under ROC for APACHE II was 0.75 and for GCS was 0.943 respectively. It was observed that both systems have adequate value in predicting mortality; however, GCS was found to be more accurate when compared to APACHE II.

Similar results were found in study done by Mc Nett et al in 2007. He investigated if correlation exists between variables in acute stage of injury and outcome measures in TBI patients. GCS was the score which was extensively studied along with other scores and found that GCS was most accurate in predicting outcome in head injury patients. Recently similar study was done by Hosseini et al in 2016 that compared APACHE II and GCS in predicting the outcome in post anesthesia care unit patients. This study concluded that survivors had significantly lower APACHE II and higher GCS compared with non survivors and GCS show more predictive accuracy than APACHE II in prognosticating the outcome in PACU.

CONCLUSION

The present study concluded that GCS as well as APACHE II both are comparable in predicting outcome in head injury patients. GCS is simple, less time consuming and more accurate for predicting early outcome than APACHE II. But for prediction of late mortality, the APACHE II has better accuracy than GCS.

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