

# Study of APACHE II score and National Institutes of Health Stroke Scale as prognostic indicators in cerebrovascular accidents patients admitted in a tertiary care center, Rewa



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## ABSTRACT

**Background:** Stroke is the 2<sup>nd</sup> largest cause of mortality world over. In the intensive care unit (ICU), severity scales are crucial adjuncts of treatment for anticipating patient outcomes, comparing quality of care, and stratification for clinical studies. They are an important aspect of making better health-care judgments and identifying people with unusual outcomes. This study was conducted to assess and compare Acute Physiology and Chronic Health Evaluation II (APACHE II) score and National Institutes of Health Stroke Scale (NIHSS) score as predictors of mortality in cerebrovascular accident (CVA) patients admitted in medical intensive care unit (ICU) of tertiary care center, Rewa. **Aims and Objectives:** To evaluate APACHE II score, NIHSS score and APACHE II + NIHSS score as a predictor of short term mortality in CVA patients. **Materials and Methods:** This was a cross-sectional, analytical study conducted in the Department of Medicine, Sanjay Gandhi Memorial Hospital, associated with Shyam Shah Medical College, Rewa (M.P), between January 2020 and June 2021. The APACHE II score, NIHSS score, and APACHE II+NIHSS scores were calculated for each patient on day of admission and patients were followed up for a maximum period of 7 days. The area under receiver operating characteristic (ROC) curve was used to measure the ability of these scoring systems to forecast the prognosis, to find the best dividing value. **Results:** Out of 154 patients of CVA, 102 were male and 52 were female. In both sexes, the highest frequency of CVA was seen in those over 55 years of age. The mean age of the participants in the study was  $62.70 \pm 12.62$  years while it was  $61.98 \pm 12.83$  years for males and  $64.13 \pm 12.19$  years for females. The mean APACHE II score in death group was  $29.45 \pm 10.095$ , mean NIHSS score in death group was  $32.45 \pm 6.486$ , and the mean of both scores combined in death group was  $61.91 \pm 14.017$  and the mean of APACHE II score in survival group was  $12.92 \pm 6.478$ , mean NIHSS score in survival group was  $14.09 \pm 8.099$ , and the mean of both scores combined in survival group was  $27.76 \pm 14.090$ . The APACHE II score had an area under the curve (AUC) of 0.919 which is slightly more than the NIHSS score which had the AUC of 0.913 and the sum of the two scores had the highest area under the ROC curve which is 0.947. According to Youden's index, the dividing value for the APACHE II score is 21, the NIHSS score is 22, and APACHE II+NIHSS score was 42. **Conclusions:** Application of APACHE II and NIHSS scores provides an objective method to decide prognosis and plan management of CVA patients. It also helps in deciding whether the patient needs to manage in neurology ward or ICU depending on the dividing value. Both the scores have good ability to predict the short-term prognosis of CVA patients and the combination of these two can provide an even better measure of mortality.

**Key words:** Acute Physiology and Chronic Health Evaluation II; Cerebrovascular accident; National Institutes of Health Stroke Scale

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## INTRODUCTION

A stroke, also called as a cerebrovascular accident (CVA), is a sudden start of a neurologic deficit caused by a focal vascular etiology. As a result, the clinical definition of stroke is utilized, and laboratory procedures such as brain imaging are used to confirm the diagnosis.<sup>1</sup> Stroke is the 2<sup>nd</sup> largest cause of mortality, with 6.2 million people dying from it in 2015, rising from 830,000 in 2000 worldwide. It is also the second most common cause of disability world over.<sup>1</sup> Stroke is one of the leading causes of death and disability in India. The estimated prevalence rate of stroke ranges from 84–262/100,000 in rural areas and 334–424/100,000 in urban areas. The incidence rate is 119–145/100,000 based on the recent population-based studies.<sup>2</sup>

In the intensive care unit (ICU), severity scales are crucial adjuncts of treatment for anticipating patient outcomes, comparing quality of care, and stratification for clinical studies. They are an essential part of improvement in clinical decisions and in identifying patients with unexpected outcomes. Although the prediction models confront several problems, efficient implementation of these models aids in timely decision-making and lowers health-care bills.<sup>3</sup>

Although the Acute Physiology and Chronic Health Evaluation II (APACHE II) scoring system has been validated for benchmarking and mortality forecasts, only a few papers have been published to show that it is effective in neurological patients.<sup>4</sup> The National Institutes of Health Stroke Scale (NIHSS) is a metric used by health-care practitioners to objectively evaluate the damage produced by a stroke. The NIHSS consists of 11 items, each of which is scored on a scale of 0–4 for a certain ability. A score of 0 for each item shows normal function in that particular skill, whereas a higher number suggest some amount of impairment.<sup>5</sup>

The combination of the two scores was also used by Zhao *et al.*,<sup>6</sup> in their study as prognostic markers in acute cerebral hemorrhage patients to assess its superiority over either score when used alone. We, in our study, have also compared the sum of APACHE II and NIHSS score with both the scores when used separately.

The following study aims to compare the short-term (7 day) outcome of the patients admitted with the diagnosis of stroke with values of each of the two scoring systems to determine the ability of each of the two scoring systems to predict short-term mortality. On conducting a detailed literature review, it is found that very few studies comparing the above two scores have been conducted in the Indian medical setup and hence the importance of conducting this research.

## Aims and objectives

To evaluate APACHE II score, NIHSS score and APACHE II + NIHSS score as a predictor of short term mortality in CVA patients.

## MATERIALS AND METHODS

The present prospective cross-sectional analytical study carried out in ICU of the Department of Medicine, Sanjay Gandhi Memorial Hospital (SGMH), Rewa. A total of 154 cases of CVA primarily diagnosed by clinical examination and further evaluated by available Brain imaging modality, namely, computed tomography (CT) scan and magnetic resonance imaging (MRI) were taken for study during a period from January 2020 to June 2021. Detailed history was taken and thorough examination (general and systemic) of patient, GCS score grading and NIHSS scoring were done. Informed consent was obtained from patients. The study was pre-approved by the Institutional Ethics Committee for the final permission.

### Inclusion criteria

- All patients more than 15 years of age presenting with 1<sup>st</sup> episode of stroke in medical intensive care unit, SGMH, Rewa, were included in the study.

### Exclusion criteria

The following criteria were excluded from the study:

- Patients <15 years of age
- Patients with prior stroke
- Patients with stroke having comorbidities such as
  - Chronic kidney disease
  - CLD
  - Coronary artery disease patients
  - Brain tumors
  - Post-traumatic intracranial hemorrhage.

Detailed history was recorded with respect to presenting symptoms, type of exposure, and a complete general and systemic examination was carried out.

Patient's pro forma was maintained which included the clinicodemographic particulars, investigations of the patients, and final calculated APACHE II, NIHSS, and APACHE II + NIHSS scores on the day of admission. The patients were followed up for a period of maximum 7 days. The outcome of the patients at the end of 1 week was determined as survivors (which includes the deeply comatose patients and patients on ventilatory support or inotropic support at the end of 1 week) and expired (which includes both in hospital and post discharge mortality). The study was approved by ethical committee of the institute and informed consent was obtained from every case.

### Statistical analysis

Data were collected and managed on an Excel worksheet and the mean values were calculated and denoted as mean±standard deviation. Appropriate statistical tests were used to determine significance of values. APACHE II score, NIHSS, and APACHE II + NIHSS for each patient were correlated with the outcome within the 1<sup>st</sup> week and receiver operating characteristic (ROC) curves for each were obtained using SPSS software. P<0.05 was considered statistically significant. Youden’s index was also measured using the ROC curves on SPSS software to find the best dividing value for all the three scores. It allows for the selection of an ideal dividing value (cutoff point) for a diagnostic marker while also measuring its usefulness.

### RESULTS

Out of 154 patients of CVA, 102 were male and 52 were female. The maximum prevalence of CVA was observed in the age group of 56–65 years (28.57%) in both the sexes (Table 1).

The mean APACHE II score in the death group is 29.45±10.095, mean NIHSS score in the Death group is 32.45±6.486, and the mean of both scores combined in the death group is 61.91±14.017 and the mean of APACHE II score in the survival group is 12.92±6.478, mean NIHSS score in the survival group is 14.09±8.099, and the mean of both scores combined in the survival group is 27.76±14.090 (Table 2).

The APACHE II score has an area under the curve (AUC) of 0.919 which is slightly more than the NIHSS score which has the AUC of 0.913 and the sum of the two scores has the highest area under the ROC curve which is 0.947. According to Youden’s index, the dividing value for the APACHE II score was 21, the NIHSS score was 22, and APACHE II+NIHSS scores was 42 (Table 3) (Figure 1).

### DISCUSSION

In the present study, the mean age of males was 61.98±12.83 years and the mean age of females was 64.13±12.19 years. The overall mean age of patients in our study was 62.71±12.62 years which correlated with the study conducted by Maskey *et al.*, (mean age 63 years).<sup>7</sup> The distribution of stroke is maximum in the age group of 51–60 years which comprised 30.5% of total patients which closely correlates with the study done by Ukoha *et al.*,<sup>8</sup> and Maskey *et al.*<sup>7</sup> Similar observation was found in studies conducted by Aiyer *et al.*,<sup>9</sup> where it was shown that 64% belonged to more than 50 years.

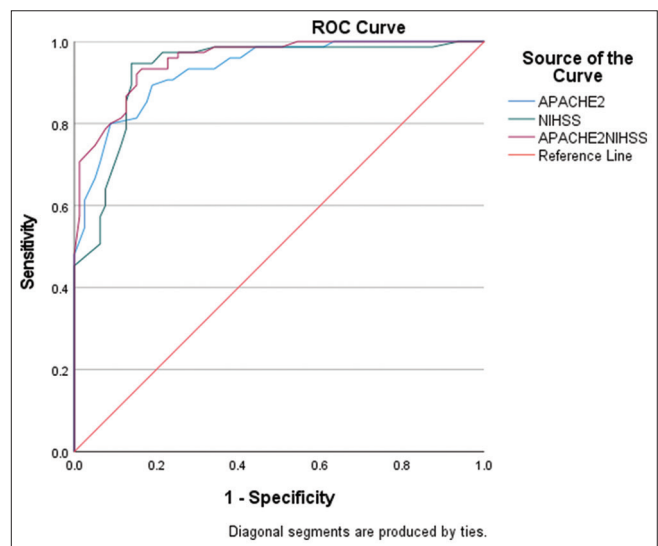
**Table 1: Distribution of cases according to age and sex**

Age (in years)	Males Mean age 61.98±12.83		Females Mean age 64.13±12.19		Total Mean age 62.70±12.62	
	No	%	No	%	No	%
≤45	16	15.68	03	5.76	19	12.33
46–55	23	22.54	12	23.07	35	22.72
56–65	26	25.49	18	34.61	44	28.57
66–75	20	19.60	10	19.23	30	19.48
>75	17	16.66	09	17.30	26	16.88
Total	102	100.0	52	100.0	154	100.0

**Table 2: Mean score comparison of CVA patients in the survival group and death group**

Outcome	APACHE ii	NIHSS	APACHE2+NIHSS
Death group (Mean)	29.45±10.095	32.45±6.486	61.91±14.017
Survival group (Mean)	12.92±6.478	14.09±8.099	27.76±14.090

P<0.001 statistically significant, CVA: Cerebrovascular accident, NIHSS: National Institutes of Health Stroke Scale, APACHE II: Acute Physiology and Chronic Health Evaluation II



**Figure 1:** Receiver operating characteristic curve of Acute Physiology and Chronic Health Evaluation II (APACHE II), National Institutes of Health Stroke Scale (NIHSS), and APACHE II+NIHSS curves showing area under the curve for all the three scores. Maximum area under the curve is for APACHE II+NIHSS score followed by APACHE II score and the least is of NIHSS score

In the present study, young stroke (age ≤45 years) comprised 12.34% of all patients which closely correlates with the study done by Sallam and Al-Aghbari<sup>10</sup> (13.6%), Gauri *et al.*,<sup>11</sup> (19%), and Chitrambalam *et al.*<sup>12</sup>

The increase in the distribution of stroke among patients more than 50 years can be due to atherosclerosis. Among

**Table 3: Comparison result of the area under the ROC curve of the scores for CVA patients**

Scores	Area under the curve	Std. error <sup>a</sup>	Asymptotic sig. <sup>b</sup>	Asymptotic 95% confidence interval	
				Lower bound	Upper bound
APACHE ii	0.919	0.021	0.000	0.878	0.959
NIHSS	0.913	0.024	0.000	0.866	0.960
APACHE ii+NIHSS	0.947	0.016	0.000	0.916	0.979

NIHSS: National Institutes of Health Stroke Scale, APACHE II: Acute Physiology and Chronic Health Evaluation II, ROC: Receiver operating characteristic, P<0.0001 statistically significant, <sup>a</sup>Under nonparametric assumption, <sup>b</sup>Null hypothesis: true area 0.5

young age group, it can be due to changing lifestyles, sedentary habits, rising stress levels, etc.<sup>13</sup> In the present study, the male-to-female ratio was 1.97:1 which correlates with the study done by Aiyar *et al.*, (1.9:1).<sup>9</sup>

In our study, the mean APACHE II score in the death group is 29.45±10.095, mean NIHSS score in the death group is 32.45±6.486, and the mean of both scores combined in the death group is 61.91±14.017 and the mean of APACHE II score in the survival group is 12.92±6.478, mean NIHSS score in the survival group is 14.09±8.099, and the mean of both scores combined in the survival group is 27.76±14.090. This result correlates closely with the results of Zhao *et al.*,<sup>6</sup> Wang *et al.*,<sup>14</sup> and Li *et al.*<sup>15</sup>

In the present study, ROC curve was drawn for all the three scores namely APACHE II score, NIHSS score, and APACHE II+NIHSS scores. The APACHE II score had an AUC of 0.919 which is slightly more than the NIHSS score which had the AUC of 0.913 and the sum of the two scores had the highest area under the ROC curve which is 0.947. According to Youden's index, the dividing value for the APACHE II score was 21 and the NIHSS score was 22. These findings are consistent with those of Zhao *et al.*,<sup>6</sup> who discovered that the areas under the ROC curve of APACHE II and NIHSS scores in forecasting CVA prognosis were 0.853 and 0.845, respectively, using 15 and 17 as the dividing value. They also concluded that the predictive accuracy of the combined model was better than either used alone. Similar findings were also established by Wang *et al.*<sup>14</sup>

Our study establishes strongly what the previous studies observed that both the scores either used separately or together have very strong ability to predict the mortality in CVA patients. These must be routinely applied in all the stroke patients being admitted in the hospital to decide the prognosis and plan the line of management of the stroke patients for proper usage of hospital's and patients resources, and timely intervention for better outcomes. It also helps in deciding whether the patient needs to manage in neurology ward or ICU depending on the dividing value.

#### Limitations of the study

1. The case selection for this study was sequential case selection.

2. The study had small sample size.
3. The study does not evaluate the correlation of the scores with functional outcome (morbidity).

## CONCLUSIONS

The distribution of stroke was found to be more among patients aged more than 55 and was more common in males than females. From the comparison of APACHE II score and NIHSS score, it can be concluded that both the scores are good at predicting the short-term outcome in terms of mortality in stroke patients and the combination of the two scores is slightly better than either used alone.

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## REFERENCES

1. Powers AC, Niswender KD, Evans-Molina C, Jameson JL, Fauci AS, Kasper DL, *et al.* Harrison's Principles of Internal Medicine. 20<sup>th</sup> ed. New York: McGraw-Hill; 2020. p. 3068. Available from: <https://accessmedicine.mhmedical.com/content.aspx?bookid=2129&sectionid=192288322> [Last accessed on 2022 April 14].
2. Pandian JD and Sudhan P. Stroke epidemiology and stroke care services in India. *J Stroke*. 2013;15(3):128-134. <https://doi.org/10.5853/jos.2013.15.3.128>
3. Heldwein MB, Badreldin AM, Doerr F, Lehmann T, Bayer O, Doenst T, *et al.* Logistic organ dysfunction score (LODS): A reliable postoperative risk management score also in cardiac surgical patients? *J Cardiothorac Surg*. 2011;6:110. <https://doi.org/10.1186/1749-8090-6-110>
4. Akavipat P, Thinkhamrop J, Thinkhamrop B and Sriraj W. Acute physiology and chronic health evaluation (APACHE) II score- the clinical predictor in neurosurgical intensive care unit. *Acta Clinica Croatica*. 2019;58(1):50. <https://doi.org/10.20471/acc.2019.58.01.07>
5. Ortiz GA and Sacco RL. National institutes of health stroke scale (NIHSS). Hoboken, New Jersey: Wiley Encyclopedia of Clinical Trials. 2007. p. 1-9. <https://doi.org/10.1002/9780471462422.eoct400>
6. Zhao XJ, Li QX, Chang LS, Zhang J, Wang DL, Fan HY, *et al.* Evaluation of the application of APACHE II combined with NIHSS

- score in the short-term prognosis of acute cerebral hemorrhage patient. *Front Neurol.* 2019;10:475.  
<https://doi.org/10.3389/fneur.2019.00475>
7. Maskey A, Parajuli M and Kohli SC. A study of risk factors of stroke in patients admitted in Manipal Teaching Hospital, Pokhara. *Kathmandu Univ Med J.* 2011;9(4):244-7.  
<http://dx.doi.org/10.3126/kumj.v9i4.6337>
  8. Ukoha OB, Ajaegbu O and Eke CO. A review of stroke cases in a military hospital in Nigeria. *Afr Med J.* 2012;3(2):31-33. Available from: <https://www.ajol.info/index.php/afrij/article/view/86578> [Last accessed on 2022 April 14].
  9. Aiyar I. A study of clinic-radiological correlation in cerebrovascular stroke (a study of 50 cases). *Guj Med J.* 1999;52:58-63.
  10. Sallam AR and Al-Aghbari K. The clinical profile of stroke: A Yemeni experience. *J Med J.* 2009;43(2):115-121. Available from: <https://journals.ju.edu.jo/JMJ/article/view/908> [Last accessed on 2022 April 14].
  11. Gauri LA, Kochar DK, Joshi A, Jain R, Gupta S and Saini G. A study of risk factors and clinical profile of stroke at Bikaner. *J API.* 2000;48(1):56.
  12. Chitrambalam P, Baskar D and Revathy S. A study on stroke in young and elderly in Rajiv Gandhi government general hospital, Chennai. *Int J Clin Med.* 2012;3:1 Available from: <http://www.scirp.org/journal/PaperInformation.aspx?PaperID=19385> [Last accessed on 2022 April 14].
  13. Ferri CP, Schoenborn C, Kalra L, Acosta D, Guerra M, Huang Y and Jacob KS. Prevalence of stroke and related burden among older people living in Latin America, India and China. *J Neurol Neurosurg Psychiatry.* 2011;82(10):1074-82.  
<http://dx.doi.org/10.1136/jnnp.2010.234153>
  14. Wang D, Zhao X and Zhang J. Value of acute physiology and chronic health condition evaluation II and national institute of health stroke scale in evaluating outcome of patients with acute cerebral infarction. *J Clin Neurol.* 1995;1(4):251-253. Available from: <https://pesquisa.bvsalud.org/portal/resource/pt/wpr-595671?lang=en> [Last accessed on 2022 April 14].
  15. Li QX, Zhao XJ, Fan HY, Li XN, Wang DL, Wang XJ, et al. Application values of six scoring systems in the prognosis of stroke patients. *Front Neurol.* 2020;30(10):1416.  
<https://doi.org/10.3389/fneur.2019.01416>

**Authors Contribution:**

**SKT**- Concept and design of the study, prepared first draft of manuscript; **PI**- Interpreted the results, reviewed the literature, and manuscript preparation; **DKM**- Concept, coordination, statistical analysis, and interpretation; and **MI**- Preparation of manuscript and revision of the manuscript.

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