ORIGINAL ARTICLE

PREDICTORS OF EARLY MORTALITY IN ANTERIOR CIRCULATION STROKE
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HOW TO CITE THIS ARTICLE:
Konatham Rambabu, Duvvada Vijayababu. "Predictors of Early Mortality in Anterior Circulation Stroke". Journal of Evidence based Medicine and Healthcare; Volume 2, Issue 30, July 27, 2015; Page: 4447-4458, DOI: 10.18410/jebmh/2015/628

ABSTRACT: To assess and evaluate the significance of common clinical parameters as independent indices of mortality in stroke. To evaluate and correlate Rodrigues and Joshi’s prognostic score with Bandolier’s prognostic index as predictors of early mortality in stroke victims. AIM OF THE STUDY: To assess and evaluate the significance of common clinical parameters as independent indices of mortality in stroke. To evaluate and correlate Rodrigues and Joshi’s prognostic score with Bandolier’s prognostic index as predictors of early mortality in stroke victims. KEYWORDS: Stroke, Mortality.

INTRODUCTION: Globally, Stroke is the third leading cause of death preceded only by cardiac disease and malignancy.¹ The incidence of stroke increases with age. It is a major cause of disability also. As the elderly population grows with improved health care, it is projected that stroke related deaths will double by 2030.¹ A thorough knowledge by the treating physician on aetiopathology, risk factors and management of strokes will help in reducing stroke related mortality. Stroke, or cerebrovascular accident (CVA)² by definition is a syndrome of rapidly developing clinical signs of focal or global disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death with no apparent cause other than of vascular origin. The world-wide incidence of stroke has been quoted as 2/1000 population/annum; about 4/1000 in people aged 45-84 years.³ In India the incidence of cerebrovascular disease was found to be 13/100,000 population/year in a study conducted at Vellore in 1969-71 and 33/100,000 / year in a study conducted at Rohtak. A WHO study, in 1990 quoted incidence of mortality due to stroke in India to be 73/100,000 per year.⁴ In urban India, stroke accounts for 1% mortality of all hospital admissions, 4% of all medical cases and about 20% of all the disorders of central nervous system.⁵ Case fatality rates after a first ever stroke (all types) are:⁶
- 12% - 7 days.
- 19% - 30 days.
- 31% - 1 year.

About 20% of those with first ever stroke will be dependent on another person for everyday activities at 12 months while 50% will be independent. The prognosis is worse for a second stroke. It is rather difficult to prognosticate outcome/mortality when a patient comes to a physician with a fully evolved or an evolving stroke. No rules have yet been formulated that allow one to predict the early course with confidence. Several factors influence the prognosis in CVA. In very large infarcts, swelling of the infacted tissue may occur, followed by displacement of cerebral structures, tentorial herniation and death of the patient. This can be anticipated by the...
sheer volume of the infarct and is usually evident on the CT scan within a day of stroke. Smaller lesions on the inferior surface of the cerebellum may also cause a fatal herniation into the foramen magnum. Many possibilities exist for eventual or long term prognosis. Improvement is the rule if patient survives. So, it becomes necessary to identify the predictors of early mortality in a patient with stroke. Many scoring systems have been developed to predict the outcome of stroke. The widely used NIH Stroke scale,\(^7\) Canadian Neurological scale\(^6,3\) assess the severity of stroke based on clinical factors and the modified Rankin scale deals with the functional aspects of stroke patients. The immediate outcome for a patient after a cerebrovascular accident can be predicted using a prognostic score based on early clinical findings. This score was developed by Dr. Rodrigues and Joshi in India at the BYL Nair Hospital in Mumbai.\(^9\)

Bandolier prognostic index \(^{10}\) is another such scoring system to predict early mortality. This study has attempted, to identify the factors which predict early mortality in stroke and to evaluate the utility of these two scoring systems and compare results obtained by these two systems.

**MATERIALS AND METHODS:** Single centre observational, prospective and hospital based study. Stroke patients as defined by WHO criteria were included in the study. It is defined as rapidly developing clinical signs of focal or global neurological deficit with no apparent cause other than vascular origin. Patients with subarachnoid haemorrhage or other structural or metabolic or traumatic causes for the clinical features were excluded. Patients with serious infections or other systemic diseases (apart from the parameters considered) which could alter the clinical course e.g. Rheumatic heart disease were excluded. Patients with features of posterior circulation stroke were excluded. All patients were subjected to computed tomography (CT) investigation of brain.

Single centre observational, prospective and hospital based study.

**INCLUSION AND EXCLUSION CRITERIA:**

1. Stroke patients as defined by WHO criteria were included in the study. It is defined as rapidly developing clinical signs of focal or global neurological deficit with no apparent cause other than vascular origin.
2. All patients who presented within 24 hours of onset of stroke and who gave informed consent to participate in the study were included.
3. Patients with subarachnoid haemorrhage or other structural or metabolic or traumatic causes for the clinical features were excluded. Patients with serious infections or other systemic diseases (apart from the parameters considered) which could alter the clinical course e.g. Rheumatic heart disease were excluded.
4. Elaborate history was taken from all patients or from their attenders. Special emphasis was given to their age, presence of hypertension diabetes and history of previous stroke. History of smoking and prior coronary artery disease was sought.
5. Patients with features of posterior circulation stroke were excluded.
6. All patients were subjected to computed tomography (CT) investigation of brain.
ENDPOINT: The primary end point was the outcome of the patient after 7 days of onset of stroke either death or survival. Following factors were considered and analyzed as predictors of mortality:

1. Age.
2. Sex.
3. Diabetes Mellitus.
4. Hypertension.
5. Grading of mental obtundation at onset.
   - Grade 0 - Patients alert and well oriented.
   - Grade 1 - Drowsy but arousable.
   - Grade 2 - responding to deep, painful stimuli only.
   - Grade 3 - deeply comatose, not responding to deep painful stimuli.
6. Previous stroke.
7. Stroke subtype - Haemorrhage or infarct on CT scan.
8. Persistent altered consciousness after 48 hours.
9. Altered consciousness appearing in first 24 to 72 hours.
10. Presence of complete hemiplegia.
11. Seizures during hospital stay.
12. Aspiration pneumonitis.
13. Body temperature: Oral temperature was recorded on admission. It is usually 0.5°C less than core temperature.
14. Blood glucose in first 24 hours after stroke onset.
15. Presence of dysphagia.
16. Presence of urinary incontinence.

All patients were also submitted to scoring by using:
- Rodrigues and Joshi’s score.
- Bandolier prognostic index.
- CT Scoring.

**Bandolier Prognostic Index:**

| Parameter | Point |
|-----------|-------|
| i) Impaired consciousness. | 5 |
| ii) Urinary incontinence. | 4 |
| iii) Dysphagia. | 3 |
| iv) Admission temp. (≥ 100°F). | 2 |
| v) Hyperglycemia (≥ 126 mg/l) with no history of diabetes. | 2 |

Total Score = Sum (i) to (v). A score above 11 was taken as a predictor of mortality.
CT Scoring:

| CT features                                              | Finding | Points |
|----------------------------------------------------------|---------|--------|
| Massive and/or multiple lesions (Involving >1/3 of area  | Yes     | +30    |
| supplied by the artery                                   | No      | 0      |
| Gross mass effect                                        | Yes     | +22    |
|                                                           | No      | 0      |
| Constant                                                 |         | +3     |

Total Score = 1+2+3

A score more than 33 was taken as a predictor of mortality.

**STATISTICAL METHODS:** Statistical analysis was done using chi-square test for non-continuous data.

\[
\text{Degrees of freedom} = (R - 1) \times (C - 1)
\]

\[
\chi^2 = \sum \frac{(O-E)^2}{E}
\]

O → Observed outcome  
E → Expected outcome

The chi-square chart was consulted to get 'p' value. The required 2-tailed significance level for all tests was set at 0.05.

Statistical analysis was done using students 't' test for continuous data. The required 2-tailed significance level for all tests was set at 0.05.

| S. No | Clinical parameter                                      | Finding | Points |
|-------|---------------------------------------------------------|---------|--------|
| 1.    | Age (in years)                                         |         | 0.4 x (age) |
| 2.    | History of previous stroke                             | Yes     | +18    |
|       |                                                         | No      | 0      |
| 3.    | Mental obtundation at onset                             | Grade 0 | 0      |
|       |                                                         | Grade 1 | +8     |
|       |                                                         | Grade 2 or 3 | See below |
| 4.    | Persistent altered consciousness (Beyond first 48 hours)| Yes     | +40    |
|       |                                                         | No      | 0      |
| 5.    | Altered consciousness Appearing in first 24-72 hours    | Yes     | +23    |
|       |                                                         | No      | 0      |
| 6.    | Complete hemiplegia                                    | Yes     | +6     |
|       |                                                         | No      | 0      |
| 7.    | Seizures during hospital stay                           | Yes     | +15    |
|       |                                                         | No      | 0      |
| 8.    | Aspiration pneumonia                                   | Yes     | +32    |
|       |                                                         | No      | 0      |
| 9.    | Constant                                               |         | -21    |

Total sum 1 to 9
Rodrigues and Joshi’s System: A score of 63 and above was taken as a predictor of mortality.

RESULTS AND OBSERVATIONS: A total of 160 patients admitted with diagnosis of anterior circulation stroke during the study period were included in the study. Of these 82 (51.25%) were men and 78 (48.75%) were women. Among these 133 (83.13%) suffered infarction and 27 (16.88%) had intracerebral haemorrhage. Their ages ranged from 30 to 86. The mean age was 54.65.

Stroke Subtype and Death:

| Stroke Type | Survived | Death | Total | P value |
|-------------|----------|-------|-------|---------|
| Infarct     | 117 (88%) | 16 (12%) | 133 (85%) | <0.01 |
| Hemorrhage  | 14 (51.9%) | 13 (48.1%) | 27 (16.9%) |       |
| Total       | 131 (81.9%) | 29 (18.1%) | 160 (100%) |       |

Age and Death: Only one out of 29 in the below 40 age group (3.3%) and 18 out of 65 (27.7%) in the 60 and above age group died. There was a significant increase in mortality (P = 0.013) with increasing age.

Sex and Death: Fifteen out of 82 men (18.3%) and 14 out of 78 women (17.9%) died. There was no significant correlation (P = 0.95) observed between sex and the outcome.

Diabetes and Outcome:

| Diabetes Status | Survived | Death | Total | P value |
|-----------------|----------|-------|-------|---------|
| Yes             | 45 (69.2%) | 20 (30.8%) | 65 (40.6%) | <0.01 |
| No              | 86 (90.5%) | 9 (9.5%) | 95 (59.4%) |       |
| Total           | 131 (81.9%) | 29 (18.1%) | 160 (100%) |       |

Hypertension and Outcome:

| HT / Outcome | Survived | Death | Total | P value |
|--------------|----------|-------|-------|---------|
| Yes          | 62 (70.5%) | 26 (29.5%) | 88 (55.0%) | <0.01 |
| No           | 69 (95.8%) | 3 (4.2%) | 72 (45.0%) |       |
| Total        | 131 (81.9%) | 29 (18.1%) | 160 (100%) |       |
Previous Stroke and Outcome:

|       | Survived | Death | Total | P value |
|-------|----------|-------|-------|---------|
| Yes   | 16 (48.5%) | 17 (51.5%) | 33 (20.6%) | p < 0.01 |
| No    | 115 (90.6%) | 12 (9.4%) | 127 (79.4%) | |
| Total | 131 (81.9%) | 29 (18.1%) | 160 (100%) | |

Mental Obtundation and Outcome:

|       | Survived | Death | Total | P value |
|-------|----------|-------|-------|---------|
| Grade 0 | 88 (100%) | 0 | 88 (55%) | P < 0.01 |
| Grade 1 | 40 (76.9%) | 12 (23.1%) | 52 (32.5%) | |
| Grade 2 | 3 (21.4%) | 11 (78.6%) | 14 (8.8%) | |
| Grade 3 | 0 | 6 (100%) | 6 (3.8%) | |
| Total   | 131 (81.9%) | 29 (18.1%) | 160 (100%) | |

Persistent Altered Consciousness and Outcome:

|       | Survived | Death | Total | P value |
|-------|----------|-------|-------|---------|
| Yes   | 18 (38.3%) | 29 (61.7%) | 47 (29.4%) | p < 0.01 |
| No    | 113 (100%) | 0 | 113 (70.6%) | |
| Total | 131 (81.9%) | 29 (18.1%) | 160 (100%) | |

Altered Consciousness appearing after 24 Hours:

|       | Survived | Death | Total | P value |
|-------|----------|-------|-------|---------|
| Yes   | 2 (100%) | 0 | 2 (1.3%) | P = 0.50 |
| No    | 129 (81.6%) | 29 (18.4%) | 158 (98.8%) | |
| Total | 131 (81.9%) | 29 (18.1%) | 160 (100%) | |
Complete Hemiplegia and Outcome:

|        | Survived | Death | Total | P value |
|--------|----------|-------|-------|---------|
| Yes    | 63 (68.5%) | 29 (31.5%) | 92 (57.5%) | $P < 0.01$ |
| No     | 68 (100%)  | 0     | 68 (42.5%)  |         |
| Total  | 131 (81.9%) | 29 (18.1%) | 160 (100%) |         |

Seizures and Death:

|        | Survived | Death | Total | P value |
|--------|----------|-------|-------|---------|
| Yes    | 6 (26.1%)  | 17 (73.9%) | 23 (14.4%) | $P < 0.01$ |
| No     | 125 (91.2%) | 12 (8.8%)  | 137 (85.6%) |         |
| Total  | 131 (81.9%) | 29 (18.1%) | 160 (100%) |         |

Aspiration and Death:

|        | Survived | Death | Total | P value |
|--------|----------|-------|-------|---------|
| Yes    | 4 (12.5%)  | 28 (87.5%) | 32 (20%) | $P < 0.01$ |
| No     | 127 (99.2%) | 1 (0.8%)   | 128 (80%)  |         |
| Total  | 131 (81.9%) | 29 (18.1%) | 160 (100%) |         |

Dysphagia and Death:

|        | Survived | Death | Total | P value |
|--------|----------|-------|-------|---------|
| Yes    | 39 (59.1%) | 27 (40.9%) | 66 (41.3%) | $P < 0.01$ |
| No     | 92 (97.9%)  | 2 (2.1%)    | 94 (58.8%)  |         |
| Total  | 131 (81.9%) | 29 (18.1%) | 160 (100%) |         |
Urinary Incontinence and Death:

|                | Survived | Death | Total | P value |
|----------------|----------|-------|-------|---------|
| Yes            | 35 (54.7%) | 29 (45.3%) | 64 (40%) | P < 0.01 |
| No             | 96 (100%)  | 0     | 96 (60%) |         |
| Total          | 131 (81.9%) | 29 (18.1%) | 160 (100%) |         |

Rodrigues and Joshi Score:

|                     | Survived | Death | Total | % P value |
|---------------------|----------|-------|-------|-----------|
| Score ≥ 63          | 8 (21.6%) | 29 (78.4%) | 37 (23.1%) | P < 0.01 |
| < 63                | 123 (100%) | 0   | 123 (76.9%) |         |
| Total               | 131 (81.9%) | 29 (18.1%) | 160 (100%) |         |

Sensitivity - 100%
Specificity - 93.9%
CT Scoring:

| Score > 33 | Death | Survived | Total | % P value |
|------------|-------|----------|-------|----------|
|            | 19 (86.4%) | 3 (13.6%) | 22 (13.8%) | p < 0.01 |
| ≤ 33       | 10 (7.2%) | 128 (92.8%) | 138 (86.3%) | |
| Total      | 29 (18.1%) | 131 (81.9%) | 160 (100%) | |

Sensitivity - 65.5%
Specificity - 97.7%

Bandolier Prognostic Index:

| Score > 11 | Death | Survived | Total | P value |
|------------|-------|----------|-------|---------|
|            | 28 (57.1%) | 21 (42.9%) | 49 (30.6%) | p < 0.01 |
| ≤ 11       | 1 (0.9%) | 110 (99.1%) | 111 (69.4%) | |
| Total      | 29 (18.1%) | 131 (81.9%) | 160 (100%) | |

Sensitivity - 96.6%
Specificity - 84%

**Initial Body temperature and Blood glucose level on admission:** The mean body temperature of all patients was 99.58°F and their mean glucose level was 119.02 mg/dL. Forty eight patients had a temperature of 100°F and more and 25 of them died. Fifty one patients had blood sugar level of 126 mg/dL and more on admission and 23 of them died. There was a significant association between high body temperature and high blood glucose levels or admission and death (P value in both situations was < 0.05).

**DISCUSSION:** The total mortality observed at the end of first week in this study was 18%. In the west where acute stroke care centres are fully equipped the rate is as low as 5%. Bhalla A. et al observed a mortality of 34% at Sevagram, Wardha. In this study patients with haemorrhage had a higher mortality rate of 48% (13 out of 27 died) whereas among those with infarcts it was 12% (16 out of 133 died). Infarcts accounted for 83% of strokes and haemorrhage constituted the remaining 17%. The early mortality in stroke is reported to be around 20% in white population. Kazi et al reported an overall mortality due to all causes as 20% in all stroke patients. The Canadian Institute of health reports 30 day mortality of 18.8%. Tzong et al from Singapore found the mortality at the end of first month to be 20.3%. The all cause stroke mortality observed by Bhalla A et al was 34% an Indian study. Their study was compared with this study.
(In the current study, number of deaths includes only those that occurred within 1 week of onset of stroke). This study included patients with anterior circulation stroke only. It is a well-known fact that the mortality rate is higher among the patients with posterior circulation stroke. Perhaps that is why the mortality rate in our study is lower than that observed (18 vs 34%) by Bhalle et al, another Indian study. Also, an arbitrary period of 1 week was chosen to predict early mortality in this study whereas it was not so in the other study. Improved medical care including fully equipped stroke care units, prompt detection and complete treatment of risk factors like hypertension, diabetes and declining incidence of smoking\(^{(16)}\) may be the reasons for reduced mortality rates observed in the west.

Rodrigues and Joshi studied 120 consecutive patients at BYL Nair hospital in Mumbai, India (Period of study: August 1986 to January 1987) and predicted a prognostic score for immediate outcome based on early clinical findings.\(^{(9)}\) In their study, patients with clinical scores ≤ 46 had a 50% or better chance of survival, while patients with scores ≥ 47 had a 50% or greater chance of death. A clinical score ≤ 12 was associated with 99% chance of survival and 99% chance of death when the score was ≥ 63. Using this cut off of 63, the scoring system was found to be 100% sensitive and 93.9% specific by this study.

Bandolier prognostic index uses temperature and initial blood sugar levels apart from neurological parameters which were not considered in the Joshi's score. According to this index a score < 11 predicted 3% mortality whereas it was 75% when the score was more than 11.10. Using this cut off score the mortality in this study was less than 1% and 57% respectively. Comparing the two scoring systems both were sensitive and Joshi's scoring system was more specific than Bandoliers index. Both these scoring systems do not consider the subtype of stroke i.e. whether it was an infarct or haemorrhage. In this study a correlation between haemorrhage and death was found. Moreover none of the patients in this study group underwent evacuation of hematoma as a mode of treatment.

The important risk factors like diabetes, hypertension or smoking contribute to stroke. Atrial fibrillation (non valvular) was found to be an independent risk factor for mortality in a study conducted by Peter Apprelros and others.\(^{(17)}\) They found the 1 year mortality after stroke to be 33% in the study which comprised of 377 patients.\(^{(17)}\) Abnormal cardiac rhythm, an important factor in cardio embolic stroke is not considered while computing the scoring system. In this study strokes in patients with rheumatic heart disease were not included. Three patients had non valvular atrial fibrillation and none of them died. Hypertension and diabetes were clearly independent risk factors for early mortality in this study. The immediate prognosis for large and medium sized cerebral clots and even smaller ones in cerebellum / brainstem is grave.\(^{(18)}\) Either haemorrhage extends into ventricular system or intracranial pressure is elevated to levels that preclude normal perfusion. Sometimes the haemorrhage itself seeps into vital centers such as hypothalamus or midbrain. In patients who survive - i.e. those with smaller haemorrhages - there can be surprising degree of restoration of function, since in contrast to infarction the haemorrhage has to some extent pushed brain tissue aside rather than destroyed it.\(^{(18)}\) In this study 13 out of 27 patients with haemorrhage died (P < 0.05). Haroun M\(^{(19)}\) and others from Ain Shans University in Egypt studied early mortality predictors of death among 526 stroke patients.
They found significant association between the following parameters and death:
1. Increasing age 2. Altered conscious level on admission, 3. Presence of Bulbar symptoms 4. Previous heart disease, 5. Previous history of stroke 6. High blood pressure and 7. Increased body temperature. All associations were statistically highly significant (P< 0.01). Hypoglycemia resulted in a significant reduction in the size of early infarcts as measured by TTC staining.[20,21,22] In this study the mean blood sugar level was 119. Hyperglycemia clearly co-related with high mortality (P <0.05).

CONCLUSIONS: Hemorrhagic strokes had a poor outcome than ischemic strokes. An elevated body temperature in the acute phase and hyperglycemia on admission were associated with a poor outcome. Diabetes and hypertension are not only risk factors for stroke but they were also clear predictors for early mortality.

Increasing age of patients worsens prognosis and predicts early mortality. Conscious level was an independent predictor of outcome.

Both Rodrigues and Joshi's score and Bandolier prognostic index are simple and reliable clinical prognostic scoring systems in early mortality in stroke.

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Date of Submission: 01/07/2015.
Date of Peer Review: 02/07/2015.
Date of Acceptance: 25/07/2015.
Date of Publishing: 27/07/2015.