

Diagnostic Accuracy of NIHSS Score in Predicting in-Hospital Mortality in Patients of Ischemic Stroke taking Actual in-Hospital Mortality as Gold Standard

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Abstract: Objective: To determine the diagnostic accuracy of NIHSS score for predicting in-hospital mortality among patients of ischemic stroke taking in-hospital mortality as gold standard.

Material & Methods: The present cross-sectional study was carried out from May 2020 to November 2020 at Medicine Department, Services Institute of Medical Sciences Lahore. A total of 142 patients aged 30-70 years of both sex with ischemic stroke patients as per-operational definition of duration ≤ 24 hours were enrolled. Patients of hemorrhagic stroke, cardiac disease and CRF were excluded. After taking informed consent, NIHSS score was evaluated in each patient and in hospital mortality will be noted. All patients were followed by the researcher herself and in hospital mortality was noted.

Results: Mean age was 53.5+9.2 years with 74 (52.11%) females. Mean disease duration was 6.8+1.7 hours and mean NIHSS score was 24.3+7.1. NIHSS score was evaluated in each patient and found 75 True Positive while 06 False Positive. In the 61 NIHSS score negative patients, in-hospital mortality was seen in 06 (False Negative) while 55 (True Negative) did not have in-hospital mortality (p-value <0.001). The Specificity, Sensitivity, Negative Predictive Value (NPV), Positive Predictive Value (PPV) and diagnostic accuracy of NIHSS score to predict in-hospital mortality among patients of ischemic stroke taking in-hospital mortality as gold standard was 92.59%, 90.16%, 92.59%, 90.16% and 91.55% respectively.

Conclusion: Diagnostic accuracy of NIHSS score in predicting in-hospital mortality in ischemic stroke patients is quite high.

Keywords: Ischemic stroke, Hemorrhagic stroke, NIHSS score, In-Hospital Mortality, Hemostatic therapy, Atrial fibrillation.

INTRODUCTION

A leading cause of mortality globally, stroke is associated with almost 5.5 million deaths per annum and is a common cause of disability in adults [1]. WHO estimates stroke as the second common cause of mortality globally in 2020 [2]. Stroke is of two types: hemorrhagic and ischemic. A distinction between these must be made as management for both is different. In ischemic stroke, thrombolytic and/or anti-platelet therapies are used whereas hemostatic therapy may be used in hemorrhagic stroke. Early initiation of therapy after stroke onset leads to improved prognosis [1]. The frequency of stroke sub-types is different in different ethnic populations. Hemorrhagic stroke was two-times more commonly seen in Asian population including Chinese when compared to white European population. The etiology in this difference distribution of stroke sub-types may be due to differences in genetic and environmental risk factors and how ethnic make-up responds to these risk factors. Furthermore, younger age at

stroke onset leads to more disability in young in Asians as compared to European population [3].

In Pakistan, ischemic stroke is accountable for 60-90% stroke patients. It results from occlusion of an artery thereby obstructing blood supply to the brain. Risk factors of ischemic stroke are non-modifiable factors (age, gender, prior stroke, ethnicity, and family history) and modifiable factors (diabetes, hypertension, obesity, cardiac disease, dyslipidemia, atrial fibrillation, alcohol abuse, smoking and sedentary lifestyle) [4-6]. The modifiable risk factors are important as risk assessment and treatment of these can lead to prevention of stroke and subsequent disability and mortality [2, 4, 5]. Furthermore, there are assessment scores which help to predict outcome once an ischemic stroke has occurred [7]. The National Institute of Health Stroke Scale (NIHSS) is usually used in research and clinical practice to predict prognosis of ischemic stroke patients [8]. However, there is a disparity regarding the diagnostic accuracy of NIHSS score. In a study, sensitivity and specificity of NIHSS score in predicting in-hospital

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mortality in ischemic stroke patients were 80.9% and 57.5% respectively [9]. Another study has shown the sensitivity and specificity of NIHSS score to predict in-hospital mortality among patients of ischemic stroke were 76.0% and 87.0% respectively [10]. Zhao *et al.* has shown the in-hospital mortality among patients of ischemic stroke was found to be 30.33% and sensitivity and specificity of NIHSS score in predicting in-hospital mortality among patients of ischemic stroke were 80.4% and 76.6% respectively [11].

Since there is controversy in the available literature on diagnostic accuracy of NIHSS score in predicting in-hospital mortality among patients of ischemic stroke, so this study was planned to find out the diagnostic accuracy of NIHSS score to predict in-hospital mortality among patients of ischemic stroke, taking in-hospital mortality as gold standard in ethnic Pakistani population. The results of this study will not only help in resolving this controversy but if it's diagnostic accuracy will be found high, then we can provide these particular patients with a simple, easy and non-invasive method which can be used routinely in our general practice for detecting high risk patients for selection of timely and aggressive treatment option in order to decrease stroke morbidity & mortality in Pakistani population.

MATERIALS & METHODS

The present descriptive cross-sectional study was conducted at Medicine Department Services Hospital, Services Institute of Medical Sciences Lahore from May 2020 to November 2020. A sample of 142 patients was required with confidence level 95%, and taking estimated in-hospital mortality as 30.33% with margin of error 12% for sensitivity 80.4% and specificity 76.6% of NIHSS score in predicting in-hospital mortality among patients of ischemic stroke [9]. Patients of hemorrhagic stroke (on CT scan Brain), cardiac disease, chronic liver and renal failure as assessed by detailed history and examination were excluded from the study. Using non-probability, consecutive sampling, 142 patients with ischemic stroke patients of both sex aged 30-70 years were enrolled. After approval by ethical review committee, 142 patients admitted to Department of Medicine, Services Hospital Lahore were enrolled.

The NIHSS scale is made up of 11 different elements that evaluate effect of stroke on specific ability including level of consciousness, orientation in time and place, language, neglect, visual-field loss, extra ocular movement, facial palsy, motor strength, ataxia, dysarthria, and sensory loss. The score for each ability is a number between 0 and 4 with 0 being normal functioning and 4 being completely impaired. The patient's NIHSS score is calculated by adding the number for each element of the scale; 42 is the highest score possible. In-hospital mortality on NIHSS was taken positive as a score

of ≥ 6 . In-hospital mortality was defined as death during 7 days of hospital stay.

After taking detailed informed consent from the patient's attendant, basic demographic information, medical history with clinical examination were done and recorded. NIHSS score was evaluated in each patient and in-hospital mortality on NIHSS was noted. All patients were followed until the time of discharge/death and in-hospital mortality was noted.

Diagnostic Accuracy of NIHSS was presented in form of Specificity, Sensitivity, Negative Predictive Value (NPV) and Positive Predictive Value (PPV). Sensitivity was defined as the capacity of NIHSS score to correctly identify patients who had in-hospital mortality ($\frac{TP}{TP+FN} \times 100$). Specificity was defined as the capacity of NIHSS score to correctly identify patients who had no in-hospital mortality ($\frac{TN}{TN+FP} \times 100$). The probability that a patient with a positive NIHSS score actually have in-hospital mortality ($\frac{TP}{TP+FP} \times 100$) was labeled as Positive Predictive Value (PPV). The probability that a patient with a negative NIHSS score actually did not have in-hospital mortality ($\frac{TN}{TN+FP} \times 100$) was termed as Negative Predictive Value (NPV). True Positive were patients with actual in-hospital mortality as well as on NIHSS score. True negative were patients with no in-hospital mortality as well as on NIHSS score. False Positive were patients with no in-hospital mortality but present on NIHSS score. False Negative were patients with actual in-hospital mortality but absent on NIHSS score. Ischemic Stroke was defined according to WHO definition as presence of sudden onset (<24 hours) focal weakness (hemiplegia, aphasia, dysphasia or cranial nerve palsy), GCS <8/15 and CT scan brain (non-contrast) will show loss of gray-white interface, high attenuating (bright) clot, hypo-density of cerebral cortex.

The data was entered and analyzed through SPSS 25.0. Age, duration of stroke and Body Mass Index (BMI) were reported as mean and standard deviation. Sex, hypertension, diabetes mellitus, in-hospital mortality on NIHSS score and actual in-hospital mortality (yes/no) were presented as frequencies and percentages. Specificity, Sensitivity, Negative Predictive Value (NPV), Positive Predictive Value (PPV) and diagnostic accuracy of NIHSS score in predicting in-hospital mortality was calculated using Contingency table (2x2) in patients of ischemic stroke taking in-hospital mortality as gold standard. Effect modifiers and confounders were controlled by stratification. Chi-square test was applied to compare true and false positivity rate. P-value less than or equal to 0.05 was taken as statistically significant.

RESULTS

A total 142 patients were enrolled in the present study having mean age 53.5+9.2 years. Forty-one (28.9%) patients were

younger than 50 years while 101 (71.1%) patients were older than 50 years. Sixty-eight (47.89%) patients were males while 74 (52.11%) patients were female. Mean disease duration was 6.8+1.7 hours with 87 (61.3%) patients having disease duration <7 hours. Mean BMI was 28.2+3.3 kg/m² with 97 (68.3%) patients having BMI <30 kg/m². Seventy-seven (54.2%) patients had hypertension while diabetes mellitus was seen in 76 (53.5%) patients. Mean NIHSS score was 24.3+7.1.

NIHSS score was evaluated in each patient and demonstrated 75 (52.8%) patients as True Positive and 06 (4.2%) patients as

False Positive as shown in Table 1. Among the 61 patients with negative NIHSS score, in-hospital mortality was seen in 06 (False Negative) while 55 (True Negative) did not have in-hospital mortality (p=0.0001). Overall Specificity, Sensitivity, Negative Predictive Value (NPV), Positive Predictive Value (PPV) and diagnostic accuracy of NIHSS score in predicting in-hospital mortality among patients of ischemic stroke taking in-hospital mortality as gold standard was 90.1%, 92.5%, 90.1%, 92.5% and 91.5% respectively. Stratification of outcome (diagnostic accuracy) with demographic and clinical variables is shown in Table 2.

Table 1. Diagnostic Accuracy of NIHSS Score in Predicting in-Hospital Mortality in Patients of Ischemic Stroke taking in-Hospital Mortality as Gold Standard.

Diagnostic Accuracy of NIHSS Score	Actual in-Hospital Mortality	No Actual in-Hospital Mortality	p-value
Positive NIHSS result	75 (52.8%)	06 (4.2%)	<0.001
Negative NIHSS result	06 (4.2%)	55 (38.8%)	

Table 2. Stratification of Diagnostic Accuracy with Respect to Demographic and Clinical Variables.

Variables		Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Diagnostic Accuracy
Age	<50 years	91.3%	88.8%	92.3%	88.1%	90.2%
	>50 years	93.1%	90.7%	92.3%	89.2%	92.0%
Gender	Male	87.2%	95.2%	97.6%	76.9%	89.7%
	Female	100.0%	87.5%	87.1%	100.0%	93.2%
Disease Duration	<7 hours	90.3%	85.7%	89.4%	86.2%	88.5%
	>7 hours	96.5%	96.1%	97.3%	94.2%	96.3%
BMI	<30 kg/m ²	90.4%	94.1%	96.6%	84.2%	91.7%
	>30 kg/m ²	100.0%	85.1%	81.8%	100.0%	91.1%
Hypertension	Present	95.1%	94.4%	92.4%	95.1%	94.8%
	Absent	90.0%	84.0%	89.6%	85.7%	87.6%
Diabetes Mellitus	Present	94.2%	87.8%	86.8%	94.7%	90.7%
	Absent	91.3%	95.0%	97.6%	82.6%	92.4%

DISCUSSION

National Institute of Health Stroke Scale (NIHSS) is a component of various stroke outcome scores such as Age and NIHSS prognostic score (ANS), Get with the Guidelines Stroke risk model (GWTG Stroke), Sentinel Stroke National Audit Program (SSNAP), and THRIVE score [12-14]. Age and NIHSS prognostic score (ANS) includes age and the NIHSS score within 6 hours of ischemic stroke onset to predict mortality at 100 days [15]. However, the ANS has not been used for patients with hemorrhagic stroke, and to predict mortality during the hospital stay or at 30 days of stroke onset. For standardized reporting of mortality at 30 day in stroke patients, case mix models have been derived from the Sentinel

Stroke National Audit Program (SSNAP) in England and Wales [12]. It includes age, NIHSS, atrial fibrillation and stroke type but has not been used independently or validated for mortality at 90days [13]. To predict in-hospital deaths, mortality at 30 days and poor prognosis at 90 days (death and disability), NIHSS score remains the best option [16]. Kwiatkowski *et al.* demonstrated that NIHSS to have good reliability and validity in predicting mortality of patients with stroke [17]. Trial of ORG 10172 in Acute Stroke Treatment (TOAST) reported NIHSS to have good predictive value in long-term stroke prognosis [18]. Kwakkel *et al.* showed NIHSS could predict long-term outcomes of patients with stroke at 3 and 6 months [19]. Young *et al.* reported baseline

NIHSS score as the best indicator of functional impairment in ACI patients [20].

We conducted the present study to find out diagnostic accuracy of NIHSS score in predicting in-hospital mortality among patients of ischemic stroke taking in-hospital mortality as gold standard. NIHSS score was evaluated in each patient and found 75 patients True Positive and 06 patients False Positive. In the 61 patients with negative NIHSS score, in-hospital mortality was seen in 06 patients (False Negative) while 55 patients (True Negative) did not have in-hospital mortality (p-value <0.001). Overall Specificity, Sensitivity, Negative Predictive Value (NPV), Positive Predictive Value (PPV) and diagnostic accuracy of NIHSS score in predicting in-hospital mortality among patients of ischemic stroke taking in-hospital mortality as gold standard was 90.1%, 92.5%, 90.1%, 92.5% and 91.5% respectively. In a study, sensitivity and specificity of NIHSS score in predicting in-hospital mortality in ischemic stroke patients were 80.9% and 57.5% respectively [9]. Another study has shown the sensitivity and specificity of NIHSS score in predicting in-hospital mortality among patients of ischemic stroke were 76.0% and 87.0% respectively [10]. Zhao *et al.* showed in-hospital mortality among patients of ischemic stroke to be 30.33% and sensitivity and specificity of NIHSS score in predicting in-hospital mortality among patients with ischemic stroke were 80.4% and 76.6% respectively [11].

Muir *et al.* found that the diagnostic accuracy of NIHSS was more accurate when a score of 13 was used as cut-off value [21]. Adams *et al.* found a satisfactory prognosis in <20% patients having >15 NIHSS score [22]. Schlegel *et al.* documented NIHSS helped to predict prognosis: patients having ≥ 5 NIHSS score had more chance to be discharged; patients having NIHSS score of 6-13 were more likely to have residual disability and require rehabilitation; while patients having ≥ 13 NIHSS score had least favorable outcome requiring continued hospital care [23]. NIHSS has been used as a marker of stroke severity in both hemorrhagic and ischemic stroke. However, NIHSS score does not take into account some neurological manifestations like headache, vomiting, nystagmus, blindness, ataxia, hearing loss and these may still lead to an adverse outcome [24, 25]. Various studies reveal NIHSS as a prognostic predictor in intra-cerebral bleed and subarachnoid hemorrhage [26, 27]. Therefore, using NIHSS in routine clinical practice for all sub-types of stroke can aid in identifying patients with high risk of poor prognosis and mortality so that timely and prompt modifications in management plan may be done to help in reducing the disability and mortality in these patients.

CONCLUSION

We conclude that diagnostic accuracy of NIHSS score in predicting in-hospital mortality among patients of ischemic

stroke to be quite high. We recommend using NIHSS score in routine clinical practice to identify patients at high risk so the appropriate management steps may be taken to reduce mortality.

AUTHORS' CONTRIBUTION

Umaima Waris, Nauman Ismat Butt and Mohammad Sohail Ajmal Ghouri: Design and conception, Data analysis and interpretation, Manuscript writing.

Tehreem Shafqat, Sehrish Hameed and Aniq Anser: Data collection, Literature review, Critical revisions of manuscript.

CONFLICT OF INTEREST

Declared none.

ACKNOWLEDGEMENTS

Declared none.

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