ORIGINAL ARTICLE

Using the National Institutes of Health Stroke Scale (NIHSS) to predict the mortality and outcome of patients with intracerebral haemorrhage

CME

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Objectives To investigate whether the National Institutes of Health Stroke Scale (NIHSS) can be used to predict mortality and functional outcome in patients presenting with intracerebral haemorrhage.

Design Retrospective study of a prospectively collected cohort.

Setting Regional hospital, Hong Kong.

Patients A cohort of 359 patients presented to our hospital from 1996 to 2001 with their first-ever stroke and intracerebral haemorrhage.

Main outcome measures The sensitivity and specificity of the NIHSS with a cut-off point of 20 in predicting mortality at 30 days and 5 years, and a favourable functional outcome at 5 years.

Results A total of 359 patients were available for analysis and were divided into three subgroups according to the site and the size of the haematoma. The NIHSS can predict 30-day mortality with a sensitivity of 81% and a specificity of 90%. The NIHSS can predict 5-year mortality with a sensitivity of 57% and a specificity of 92%. In predicting favourable functional outcomes at 5 years, the NIHSS had a sensitivity of 98% and a specificity of 16%.

Conclusions The NIHSS performed on admission can be used to predict mortality at 30 days and 5 years as well as favourable functional outcome at 5 years, all with an acceptable sensitivity and specificity.

Introduction

Intracerebral haemorrhage (ICH) is a major cause of stroke among Asians. It contributes to about 10 to 15% of strokes in western countries.[1] In Hong Kong, ICH contributes to about 30% of all strokes.[2,3] The disease differs from ischaemic stroke, as it confers higher early mortality and poorer long-term outcomes.[4] A method of predicting mortality within 30 days and good long-term functional outcomes could facilitate interviews with patients and their relatives in terms of decisions for invasive and/or supportive care. For this purpose, complicated scoring systems had been created but were difficult to use in daily clinical practice. In the recent 6 years, two less complicated scoring systems have been published.[5,6] The ICH score involves a scoring system consisting of the Glasgow Coma Scale (GCS), age, infratentorial origin, ICH volume, and presence of intraventricular haemorrhage. The new ICH score uses National Institutes of Health Stroke Scale (NIHSS), admission temperature, pulse pressure, presence of intraventricular haemorrhage, and subarachnoid extension of haemorrhage. Whilst these scores are useful for clinical trials and sophisticated research, a system based on commonly assessed clinical parameters for stroke patients could be much more useful. The NIHSS score is commonly obtained in patients presenting with acute stroke. It consists of 15 items and a total score of 42 points. A score of 0 indicates no clinically relevant neurological abnormality. If a patient scores more than 20, it usually indicates a dense paralysis with impaired consciousness. We studied whether the NIHSS can provide adequate predictive information in the course of routine clinical practice.

Methods

In our hospital, all patients with acute stroke attending the Accident and Emergency Department are admitted to the Medical Department. On admission, a stroke is defined as acute if the onset of symptoms has ensued within 5 days. Patients are transferred to the

Key words
Cerebral hemorrhage; Outcome assessment (health care); Predictive value of tests; Sensitivity and specificity

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應用美國國家衛生研究院腦中風評估量表預測腦出血病人的死亡率和康復效益

目的 探討美國國家衛生研究院腦中風評估量表(NIHSS)能否用於預測腦出血病人的死亡率和康復效益。

設計 對前瞻性收集數據的組群進行回顧研究。

安排 香港一所地區醫院。

患者 1996至2001年，本醫院接收的359名首次中風兼腦出血病人。

主要結果測量 以20為界點，應用NIHSS預測在第30天和第5年死亡率，以及在第5年的康復效益情況的敏感度和特異性。

結果 本研究把359位病人按出血的位置和規模劃分為三組作分析。NIHSS對預測第30天死亡率的敏感度為81%、特異性90%；NIHSS對預測第5年死亡率的敏感度為57%、特異性92%；NIHSS對預測第5年康復效益情況的敏感度為98%、特異性16%。

結論 在病人進院時可應用NIHSS預測第30天和第5年的死亡率、以及第5年的康復效益情況，其敏感度和特異性均在可接受的水平。

neurosurgical team, only if neurosurgery is deemed necessary. From July 1996 onwards, all acute stroke patients under the care of our department were assessed by the neurology team. We entered the data of all acute stroke patients into a stroke registry. This included: demographic data, risk factors for stroke, and stroke type (ischaemic, ICH, subarachnoid haemorrhage). Non-contrast computed tomography of the brain was performed on all acute stroke patients within 24 hours after admission, and the site and the size of any haematoma recorded. All patients, who were enrolled in the first 5 years of our stroke registry with first-ever strokes and also diagnosed as having ICH, were identified for recruitment into the present study. From 1997, in our institution the NIHSS had been used prospectively by trained or certified doctors to assess stroke patients within 2 days of admission.

Patient data in the registry, in-patient hospital records, out-patient follow-up notes, and subsequent hospital admission records were retrieved and retrospectively reviewed at 5 years or more after the index stroke episode. For patients followed up in other hospitals, their electronic hospital records, including discharge summary and out-patient progress notes, were traced. Patients were followed up in the integrated clinics of our hospital and government out-patient clinics. The patients could also have been followed up by doctors in the rehabilitation hospital, and sometimes in other hospitals (when they changed their residence). The modified Rankin score was estimated at 5 years, by using all of the written information collected in the medical record and in the electronic record. We did not estimate the score before admission, so we cannot exclude other factors affecting the score, eg chronic obstructive pulmonary disease. However, such factors were not common in our cohort. Accurate classification into five grades may be difficult but classification into favourable outcome (a score of 0 to 2) or poor outcome (a score of 3 to 5) appeared reasonable. We usually described whether a patient could walk or was dependent for the activities of daily living during out-patient visits or admissions. The patients were divided into three groups according to the size and site of their haematoma. If the size of the haematoma was estimated as more than 62.5 cm^3, it was classified as massive. Haematomas smaller than 62.5 cm^3 were classified into lobar (if within the brain parenchyma) or non-lobar (if in a deep part of the brain).

The data were analysed by the Chi squared test, if appropriate (using the Statistical Package for the Social Sciences, Windows version 12.1; SPSS Inc, Chicago [IL], US). A P value of <0.05 (2-sided) was taken to be statistically significant.

TABLE 1. Baseline demographic and clinical characteristics of the whole cohort and different types of intracerebral haemorrhage (ICH)

Characteristic	Whole cohort (n=359)	Patients with small non-lobar ICH (n=239)	Patients with lobar ICH (n=68)	Patients with massive ICH (n=52)
Mean (range) age (years)	71.4 (27-98)	69.9	74.1	74.4
Male:female	192:167	141:98	28:40	23:29
No. (%) of patients with atrial fibrillation	15 (4)	13 (5)	1 (1)	1 (2)
No. (%) of patients with diabetes mellitus	66 (18)	49 (21)	8 (12)	9 (17)
No. (%) of patients with hypertension	201 (56)	144 (60)	31 (46)	26 (50)
No. (%) of patients with ischaemic heart disease	21 (6)	13 (5)	3 (4)	5 (10)
No. (%) of patients with hypercholesterolaemia	28 (8)	22 (9)	4 (6)	2 (4)
No. (%) of smokers	66 (18)	52 (22)	9 (13)	5 (10)
Mean NIHSS* score	16	13	17	32

* NIHSS denotes National Institutes of Health Stroke Scale

Results

A total of 431 patients suffering from first-ever stroke and diagnosed as having had cerebral haemorrhage were enrolled in our stroke registry during the 5-year period from 28 July 1996 to 27 July 2001. The outcome of 24 first-ever ICH patients could not be traced at the time of review. The remaining 407 patients were included in this analysis. Among these 407 patients, only 359 patients had NIHSS assessments on the day of admission.

The baseline characteristics of these 359 patients are shown in Table 1. The relationships between NIHSS assessments on admission and 30-day mortality, 5-year mortality, and the favourable functional outcome at 5 years for the whole cohort are shown in Table 2. The corresponding relationships for the three different ICH subgroups are shown in Table 3. Except for the massive ICH subgroup (in which there were too few 30-day survivors), the relationship between NIHSS assessments on admission and 30-day mortality or 5-year functional outcome holds true for all subgroups.

Age did not affect the poor outcome of those with NIHSS scores of higher than 20. However, among those with scores of less than 20, younger patients survived better (Table 4). Compared to older patients, those who were younger also had better 5-year functional outcomes regardless of NIHSS category (Table 5). In all, 41 patients had a second stroke after surviving the first 30 days. Adjustment of the results to their modified Rankin scores just before their second stroke shows that there would have been 80 favourable outcomes for those with initial NIHSS scores of 0-5, and 19 such outcomes for those with scores of 6-10. This would have further improved the overall outcome of the whole cohort with NIHSS scores of <20 (108 favourable outcomes instead of 99), and accentuated the disparity of outcomes between those with NIHSS scores of >20 and <20. By itself, age did not increase the risk of recurrent stroke over 5 years (in the group aged <60 years, the rate was 15%; and in those aged ≥60 years, it was 10%). Recurrent stroke therefore was not the cause of less favourable functional outcomes in older patients.

In total, 186 patients died during the study period, 119 within 30 days, and 67 between 30 days and 5 years. The number of patients who died of vascular causes (ie not counting aspiration pneumonia) was 35.

TABLE 2. The 30-day and 5-year mortality and favourable functional outcome rates at 5 years related to NIHSS assessments on admission*

NIHSS	No. (%)		
	30-Day mortality	5-Year mortality	Favourable 5-year functional outcome for survivors†
>20	96/120 (80)	106/120 (88)	2/24 (8)
11-20	15/61 (25)	35/61 (57)	9/46 (20)
6-10	3/56 (5)	14/56 (25)	17/53 (32)
0-5	5/122 (4)	31/122 (25)	73/117 (62)

* NIHSS denotes National Institutes of Health Stroke Scale
† P<0.0001 when using 0-20 vs >20 for 30-day, 5-year mortality and good outcome

TABLE 3. The 30-day mortality and favourable functional outcome rates at 5 years for subgroups with massive, lobar, and non-lobar (small) intracerebral haemorrhage (ICH)

NIHSS* in various subgroups	No. (%)	
	30-Day mortality	Favourable 5-year functional outcome for survivors
Massive ICH†		
>20	38/40 (95)	0/2 (0)
0-20	5/12 (42)	2/7 (29)
Lobar ICH‡		
>20	18/25 (72)	0/17 (0)
0-20	5/44 (11)	14/39 (36)
Small non-lobar ICH§		
>20	40/55 (73)	2/15 (13)
0-20	13/183 (7)	83/170 (49)

* NIHSS denotes National Institutes of Health Stroke Scale
† P<0.0001 when using 0-20 vs >20 for 30-day mortality, P=1 for functional outcome
‡ P<0.0001 when using 0-20 vs >20 for mortality and P<0.01 for good outcome
§ P<0.02 for both mortality and good outcome

TABLE 4. The 30-day mortality for different age-groups

NIHSS*	No. (%)	
	<60 Years	≥60 Years
>20†	13/16 (81)	83/104 (80)
0-20	1/56 (2)	22/183 (12)

* NIHSS denotes National Institutes of Health Stroke Scale
† P>0.05 for NIHSS>20; P<0.05 for NIHSS≤20

TABLE 5. Favourable functional outcomes at 5 years for different age-groups

NIHSS*	No. (%)	
	<60 Years	≥60 Years
>20†	2/16 (13)	0/104 (0)
0-20	43/56 (77)	56/183 (31)

* NIHSS denotes National Institutes of Health Stroke Scale
† P<0.05 when comparing two age-groups for favourable functional outcome in different NIHSS

Discussion

This study was hospital-based. Therefore patients with very minor deficits (not hospitalised whatever the reason), those who refused admission, those with severe deficits who died before admission, and those admitted to private hospitals were not included in our cohort.

When the NIHSS is used to predict 30-day mortality, it has good sensitivity (81%) and specificity

(90%) using a cut-off point of 20 (0-20 vs >20). Using the same cut-off point to predict 5-year mortality, the NIHSS has a lower sensitivity (57%) but good specificity (92%). When using an NIHSS cut-off point of ≤20 to predict a good outcome among survivors at 5 years, its sensitivity was 98% but specificity was 16%. If the cut-off point is changed from 20 to 5 (0-5 vs >5), sensitivity was reduced to 72% but specificity increased to 68%. When the NIHSS is used to predict 30-day mortality, it has good sensitivity (81%) and specificity (90%) using a cut-off point of 20 (0-20 vs >20). Using the same cut-off point to predict 5-year mortality, the NIHSS has a lower sensitivity (57%) but good specificity (92%). When using an NIHSS cut-off point of ≤20 to predict a good outcome among survivors at 5 years, its sensitivity was 98% but specificity was 16%. If the cut-off point is changed from 20 to 5 (0-5 vs >5), sensitivity was reduced to 72% but specificity increased to 68%.

In two earlier studies which have examined the impact of NIHSS on outcome in cerebral haemorrhage, Cheung and Zou[6] found that the NIHSS assessment but not the GCS was an independent predictor of mortality and outcome at 30 days. A study published in 2006 also used the NIHSS to predict outcome at 100 days, when the patients were assessed at admission.[7] The investigators assigned scores for: NIHSS assessments (0-5=0; 6-10=1; 11-15=2; 16-20=3; >20=4), the level of consciousness (alert=0; drowsy=1; stuporous=2; comatose=3), and age (<60=0; 60-69=1; 70-79=2; ≥80=3). Using a total score cut-off point of <3 to predict complete recovery and >7 to predict death, yielded a sensitivity of 74% and specificity of 84% for the former and corresponding figures for the latter were 44% and 98%.

Compared to previous scoring systems, the NIHSS alone is much simpler to use. A cut-off point at 0-20 versus >20 already achieved sufficient sensitivity and specificity for predicting 30-day mortality, close to what was reported for the original, modified and Essen ICH scores.

Furthermore, the ICH scores have not previously been studied in terms of predicting long-term prognosis; only outcome at 30 or 100 days has been reported.[5-7] For predicting favourable outcome from stroke onset at 5 years, the NIHSS alone already achieved an acceptable negative predictive value. This information is important as the busy clinician can interview relatives in terms of life-support decisions; a score of >20 means a high chance of death in 30 days and virtually no chance of favourable long-term recovery, even in patients surviving 30 days. In which case, statistically the chance the patient would die within 30 days would be 80%, and within 5 years it would be 88%. The chance of a poor outcome at 5 years from the stroke onset would be 98%.

Taking age into consideration did not affect the predictive value of a high NIHSS on 30-day mortality. However, chronological age may reflect concomitant disease burden, and less favourable response to the neurological insult. Compared with persons aged 60 to 80 years, younger patients with an NIHSS score of ≤20 had a lower 30-day mortality rate (2% vs 12%), which was statistically significant ($P<0.05$, Table 4). In predicting favourable functional outcomes among those with an NIHSS score of ≤20, younger patients (<60 years) also faired better, although this did not detract from the adverse prognosis of a high score on functional outcome (Table 5).

In conclusion, NIHSS assessments performed at admission can be used to predict the 30-day and 5-year mortality as well as long-term outcome among survivors. Irrespective of age or type of the cerebral haemorrhage, an NIHSS score of >20 is a strong predictor of death or poor functional outcome. Whilst additional information, such as age, precise location and size of the haemorrhage, intraventricular and subarachnoid extension, temperature and blood pressure may improve prognostic precision, the busy clinician may find the NIHSS sufficient for most clinical management decisions and counselling.

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