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National Institutes of Health Stroke Scale: comparison of the original versus a modified version for Singapore culture

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ABSTRACT

Introduction: Several items pertaining to dysphasia and dysarthria of the National Institutes of Health Stroke Scale (NIHSS), originally designed in the United States, were identified as culturally unsuitable in Singapore. We compared the error rates of dysphasia objects, dysphasia phrases and dysarthria words between original versus alternative items in a cohort of Singaporean subjects without dysphasia or dysarthria.

Methods: In this prospective study, 140 English-speaking Singaporean subjects without impairments of dysphasia or dysarthria had NIHSS assessment for Items 9 and 10 using the original and alternative items. Paired analyses were conducted for comparison of error rates.

Results: Error rates were high for four original dysphasia objects (Hammock: 62.9%, Cactus: 38.6%, Feather: 23.6%, Glove: 20.7%) and significantly lower for alternative items (Snail: 5%, Horse: 1.4%, Hanger: 1.4%, Car: 0%) ($p<0.001$). For dysphasia phrases and dysarthria words, error rates were low and there were no differences in error rates between original and alternative items.

Conclusion: There are cultural issues with several dysphasia objects in the original NIHSS as evidenced by high error rates, which were lowered with more culturally suitable alternatives. This study formed a basis to derive a more suitable NIHSS version for English-speaking subjects in Singapore.

Keywords: culture, dysarthria, dysphasia, National Institutes of Health Stroke Scale, Singapore

INTRODUCTION

The National Institutes of Health Stroke Scale (NIHSS) is a 15-item assessment tool that is widely used to assess neurological deficits of stroke.[1,2] Item 9 of the NIHSS assesses dysphasia via picture description, phrase reading and object identification while item 10 assesses dysarthria via word repetition.

The NIHSS was originally designed in the English language for patients in the United States (U.S.). Items used for assessment of dysphasia and dysarthria may not be suitable for countries outside of U.S. due to different cultural backgrounds and therefore may lead to false error rates. The NIHSS has been modified for cultural context and translated into various languages.[3-10] However, only one modified NIHSS was studied in comparison to the original; this was limited to dysphasia objects and did not study dysphasia phrases and dysarthria words.[11]

In Singapore, a survey of healthcare workers identified several dysphasia objects (Hammock, Cactus), dysphasia phrases (“Down to earth”, “They heard him speak on the radio last night”) and dysarthria words (Tip – Top, Baseball Player, Huckleberry) of the original NIHSS to be unsuitable in local culture.[12] The survey also showed inconsistencies in handling culturally unsuitable items. Thus, the study concluded that there was a need to derive a modified version of the NIHSS that is more suitable to the Singapore culture by replacement of the unsuitable original items with alternatives.

Individuals without dysphasia or dysarthria should have no or minimal errors on NIHSS Items 9 and 10. We compared the error rates of dysphasia objects, dysphasia phrases and dysarthria words between original versus alternative items and investigated factors associated with error rates with the original NIHSS items in a cohort of Singaporean subjects without dysphasia or dysarthria.

METHODS

This was a prospective observational study. Patients from the neurology inpatient and outpatient service at a tertiary hospital in Singapore were screened at random and recruited from January 2016 to August 2016. We recruited subjects without dysphasia or dysarthria based on exclusion of stroke from clinical assessment, who were of stroke-prone age (defined as 60 years and above) and who spoke English. Subjects with physical barriers to speech (e.g. cleft palates), known or suspected cognitive impairment or who were non-communicative for other reasons (e.g. hearing impaired) were excluded.

The selection of alternative items for the NIHSS was done by consensus of a multi-disciplinary team consisting of a senior speech therapist, a neurologist, an advanced practice nurse, and a medical student. For dysphasia objects, Hammock and Cactus were considered low frequency objects (less common) by consensus and alternative low frequency objects were identified (Table I). Two higher frequency (more common) objects were also identified and tested. Illustrations of alternative objects were retrieved from Snodgrass' Standardized Set of 260 Pictures.[13] For dysphasia phrases and dysarthria words, alternatives were selected to retain the number of syllables and phonetic structure.

The presence or absence of dysphasia and dysarthria in subjects was determined by the managing medical team. Each subject was administered item 9 and 10 of the NIHSS using the original and alternative dysphasia objects, dysphasia phrases and dysarthria words in the same encounter by one assessor (Table I). All assessors had NIHSS certification by the American Stroke Association (Colorado, United States of America).[14] In a sample of 21 patients recruited in the first month, two assessors performed independent assessment to determine the inter-rater reliability. The inter-rater reliability for composite error rate of 26 items (17 original and 9

alternatives) between the two independent assessors for the sample of 21 cases was 0.984 ($p<0.001$).

Paired comparison of error rates between original and alternative items for dysphasia objects, dysphasia phrases and dysarthria words was performed using Statistical Package for the Social Sciences (SPSS) Statistics Version 23.0. The alpha level for significance was set at 0.05.

RESULTS

Of 294 patients screened, 140 patients met the inclusion criteria (Fig. 1). The median age was 66 years (IQR 63-71), 54.3% were male, the ethnic distribution was 70.0% Chinese, 10.7% Malay, 15.0% Indian and 4.3% of other ethnicity and the highest education level profile was 0.7% with no formal education, 12.9% with primary level, 53.6% with secondary level, 22.1% with pre-university/ vocational level and 10.7% with university level and above.

Error rates for all original and alternative objects, phrases and words were obtained (Table II). The error rates for dysphasia objects in the original NIHSS that were identified as culturally unsuitable by the healthcare worker survey were 62.9% for Hammock and 38.6% for Cactus. High error rates were also found in items that were not originally identified in the healthcare worker survey as culturally unsuitable, namely 23.6% for Feather and 20.7% for Glove. For the alternative items, error rates were 5% for Snail, 1.4% for Horse, 1.4% for Hanger and 0% for Car. In the comparison between similar-frequency original and alternative dysphasia objects, there were error rates for all alternative objects ($p<0.001$) (Table III). Error rates for dysphasia phrases and dysarthria words were low for original and alternative items, with the highest error rate at 6.4% for “Tip-Top” (Table II). There were no significant differences in error rates between the original and alternative items for dysphasia phrases and dysarthria words (Table III).

In this sample of patients without dysphasia or dysarthria, having 3 or more errors on the original NIHSS for all components of dysphasia objects, phrases and dysarthria words was associated with education level of patients (p=0.003) (Table IV). There were no associations with age (p=0.489), ethnicity (p=0.396) and gender (p=0.881).

DISCUSSION

This study's findings show high error rates with dysphasia objects of Item 9 of the original NIHSS among subjects in Singapore without dysphasia or dysarthria, suggesting that they are culturally unsuitable. This is in concordance to the Irish study where unfamiliarity of original objects to a non-American population was postulated to have led to high error rates for several items of the original NIHSS.[11] These error rates were lower with alternatives that are more familiar to the local population, showing that modification for the local context will allow for more accurate assessment.

In contrast to dysphasia objects, all dysphasia phrases and dysarthria words in the original NIHSS had low error rates, even for those identified as culturally unsuitable by the healthcare worker survey. One possible explanation for this difference is direct phrase reading and word repetition do not require prior familiarity, unlike object identification. However, it may also imply that the dysphasia phrases and dysarthria words in the original NIHSS are suitable for the Singapore culture.

There was inconsistency between the healthcare worker survey and performance of subjects in this study, which shows that the perception of healthcare workers may not accurately or adequately identify the suitable items in local or cultural context. For dysphasia objects particularly, ambiguity of the pictures depicting the objects in the original version could have been

a contributory factor for high error rates. Thus, future studies investigating cultural issues of the NIHSS should involve performance by patients rather than by perception of healthcare workers, and further modified versions should be derived from objective findings in a population of subjects. Based on this study's findings, we derived a modified NIHSS version for English-speaking subjects in Singapore, modifying the dysphasia objects whilst the dysphasia phrases and dysarthria words were not changed. This is now being utilized in clinical practice. Further studies are needed to assess this modified NIHSS for its ability to discriminate between unimpaired patients and patients with dysphasia or dysarthria.

The strength of this study is it is the first to compare error rates of all components in Item 9 and Item 10 (dysphasia objects, dysphasia phrases and dysarthria words) in the original NIHSS versus alternative items. The main limitation is the lack of blinding of the assessor to the patients' diagnosis of absence of stroke before administration of the NIHSS, which could lead to potential assessor bias. This was mitigated in two ways. First, we ensured that there was good inter-rater reliability in a selected sample. Second, there was a pre-defined objective procedure for assessment to reduce subjectivity and ambiguity. For example, only one correct response was allowed for identification of dysphasia objects, and every word from the dysphasia phrases had to be correctly read. We acknowledge that NIHSS assessment for Items 9 and 10 are based on an overall impression of the performance on all components and not on a numeric threshold of incorrect responses, and this study studied individual components rather than composite subjective performance which is difficult to quantify. The sample size is limited and may not be representative of the Singapore population.

In conclusion, there were high error rates for some original dysphasia objects in subjects without dysphasia or dysarthria in Singapore, which were lowered with alternative objects selected

as more culturally appropriate. Findings from objective assessment were not consistent with subjective opinions of healthcare workers. Thus, cultural issues and objective findings are important considerations with regards to the use of the dysphasia objects in the original NIHSS.

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REFERENCES

1. Brott T, Adams HP Jr, Olinger CP, et al. Measurements of acute cerebral infarction: a clinical examination scale. Stroke 1989; 20:864-70.
2. Martin-Schild S, Siegler J, Kumar AD, Lyden P. Troubleshooting the NIHSS: question-and-answer with one of the designers. Int J Stroke 2015; 10:1284-6.
3. Oh MS, Yu KH, Lee JH, et al. Validity and reliability of a Korean version of the National Institutes of Health Stroke Scale. J Clin Neurol 2012; 8:177-83.
4. Cheung RTF, Lyden PD, Tsoi TH, et al. Production and validation of Putonghua- and Cantonese-Chinese language National Institutes of Health Stroke Scale training and certification videos. Int J Stroke 2010; 5:74-9.
5. Domínguez R, Vila JF, Augustovski F, et al. Spanish cross-cultural adaptation and validation of the National Institutes of Health Stroke Scale. Mayo Clin Proc 2006; 81:476-80.

6. Cincura C, Pontes-Neto OM, Neville IS, et al. Validation of the National Institutes of Health Stroke Scale, modified Rankin Scale and Barthel Index in Brazil: the role of cultural adaptation and structured interviewing. Cerebrovasc Dis 2009; 27:119-22.
7. Sun TK, Chiu SC, Yeh SH, Chang KC. Assessing reliability and validity of the Chinese version of the stroke scale: scale development. Int J Nurs Stud 2006; 43:457-63.
8. Hussein HM, Abdel Moneim A, Emara T, et al. Arabic cross cultural adaptation and validation of the National Institutes of Health Stroke Scale. J Neurol Sci 2015; 357:152-6.
9. Prasad K, Dash D, Kumar A. Validation of the Hindi version of National Institute of Health Stroke Scale. Neurol India 2012; 60:40-4.
10. Pezzella FR, Picconi O, De Luca A, Lyden PD, Fiorelli M. Development of the Italian version of the National Institutes of Health Stroke Scale: It-NIHSS. Stroke 2009; 40:2557-9.
11. Burns M, Somers K, McElwaine P, Harbison J. National Institutes of Health Stroke Scale object naming test in a non-American English-speaking population. Int J Stroke 2014; 9:E35.
12. Queck KK, Fabiaña NL, Woon FP, et al. Cultural issues of the National Institutes of Health Stroke Scale dysphasia and dysarthria components in Singapore - a survey of healthcare workers. Int J Stroke 2016; 11:NP93.
13. Snodgrass J, Vanderwart M. A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. J Exp Psychol Hum Learn. 1980;6:174-215.
14. NIH Stroke Scale. AHA Learning Center. Available at: https://learn.heart.org/lms/nihss Accessed September 29, 2021.

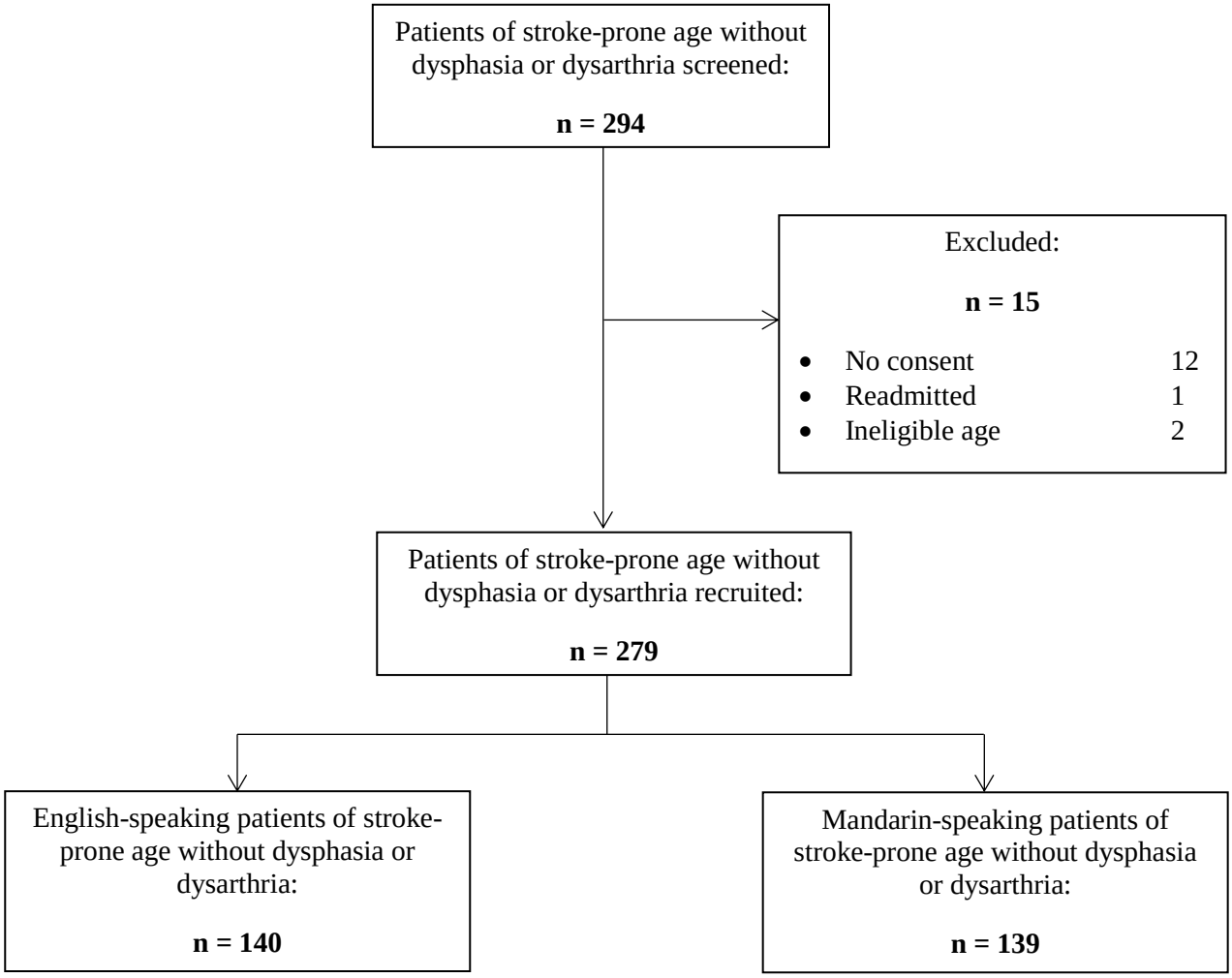


Fig. 1: Consolidated Standards of Reporting Trials (CONSORT) diagram of patients of stroke-prone age without dysphasia or dysarthria

Table I. Original and alternative items for dysphasia objects, dysphasia phrases and dysarthria words.

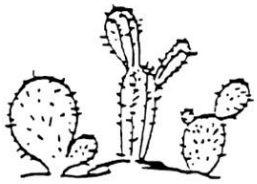
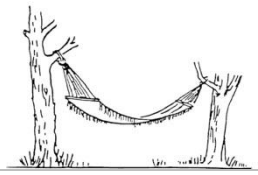
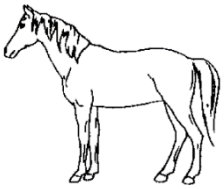
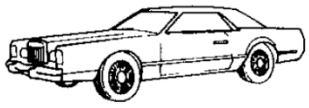
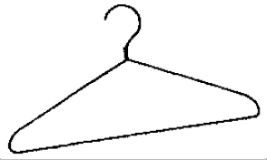
Original	**Alternatives**
Dysphasia Objects	
<u>Low frequency:</u> 1. Cactus 2. Hammock	<u>Low frequency:</u> 1. Horse 2. Snail <u>High frequency:</u> 1. Car 2. Hanger
Dysphasia Phrases	
1. Down to earth 2. They heard him speak on the radio last night.	1. Put it back. 2. We heard him speak at the wedding last night.
Dysarthria Words	
1. Tip – Top 2. Huckleberry 3. Baseball Player	1. Tick – Tock 2. Strawberry Cake 3. Football Player
<u>Dysphasia Objects</u>	
Low frequency (less common):	Low frequency (less common):
 	 
	High frequency (more common):
	 

Table II: Error rates of dysphasia objects, dysphasia phrases and dysarthria words.

	Error Rate, %
Dysphasia Objects	
Original	
Hammock*	62.9
Cactus*	38.6
Feather	23.6
Glove	20.7
Key	0.7
Chair	0.0
Alternatives	
Snail	5.0
Hanger	1.4
Horse	1.4
Car	0.0
Dysphasia Phrases	
Original	
Down to earth.*	2.9
They heard him speak on the radio last night.*	1.4
I got home from work.	3.6
Near the table in the dining room.	2.1
You know how.	1.4
Alternatives	
Put it back.	2.1
We heard him speak at the wedding last night.	1.4
Dysarthria Words	
Original	
Tip –Top*	6.4
Baseball Player*	2.1
Huckleberry*	1.4
Thanks	1.4
Fifty – Fifty	0.7
Mama	0.0
Alternatives	
Tick – Tock	2.9
Strawberry Cake	2.1
Football Player	0.0

*Item identified as culturally unsuitable from the Singapore healthcare worker survey (Put in citation)

Table III: Comparison of error rates of dysphasia objects, dysphasia phrases and dysarthria words between the original version versus alternatives in patients without dysphasia or dysarthria.

	Error Rate, %				***p* value**
	Original		**Alternatives**		
English-speaking patients (n=140)					
Dysphasia Objects	Low frequency objects				
	Hammock	62.9	Horse	1.4	< 0.001*
	Cactus	38.6	Snail	5.0	
	High frequency objects				
	Feather	23.6	Car	0.0	< 0.001[#]
	Glove	20.7	Hanger	1.4	
Dysphasia Phrases	They heard him speak on the radio last night.	1.4	We heard him speak at the wedding last night.	1.4	1.000
	Down to earth.	2.9	Put it back	2.1	1.000
Dysarthria Words	Tip – Top	6.4	Tick – Tock	2.9	0.180
	Huckleberry	1.4	Strawberry Cake	2.1	1.000
	Baseball Player	2.1	Football Playe	0.0	0.250

*Comparison of Hammock vs Horse, Hammock vs Snail, Cactus vs Horse, Cactus vs Snail
[#] Comparison of Feather vs Car, Feather vs Hanger, Glove vs Car, Glove vs Hanger
Abbreviations: NIHSS=National Institutes of Health Stroke Scale

Table IV: Associations of errors with the original NIHSS (0-2 vs 3 or more).

	0-2 errors (n=108)	**⩾ 3 errors (n=32)**	***p* value**
Age in years, median (IQR)	66.0 (62.3-71.0)	66.5 (63.0-75.8)	0.489
Ethnicity, %			0.396
Chinese	72.2	62.5	
Malay	10.2	12.5	
Indian	14.8	15.6	
Others	2.8	9.4	
Gender, %			0.881
Male	54.6	53.1	
Female	45.4	46.9	
Highest Education Level, %			0.003
No Formal Education	0	3.1	
Primary	8.3	28.1	
Secondary	52.8	56.3	
Pre-University/Vocational	25.9	9.4	
University	13.0	3.1	

Abbreviations: IQR=Interquartile Range