The Barrow Neurological Institute Screen for Higher Cerebral Functions in Cognitive Screening after Stroke

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The objective of this study was to evaluate the Barrow Neurological Institute Screen for Higher Cerebral Functions (BNIS) in screening for cognitive dysfunction at long-term follow-up after stroke in young and middle-aged patients. Within the Sahlgrenska Academy Study on Ischemic Stroke Outcome, the BNIS and the Mini-Mental State Examination (MMSE) were administered to 295 consecutive surviving patients seven years after ischemic stroke. All participants were less than 70 years at index stroke. BNIS score less than 47 and an MMSE score less than 29 were chosen to indicate cognitive dysfunction. Two hundred eighty-one (95%) patients completed both tests. The 2 test scores were moderately correlated, and both tests correlated to disability as measured by the modified Rankin Scale. The distribution of the MMSE score was skewed toward the top scores, with a marked ceiling effect, whereas the BNIS score was more normally distributed. Most BNIS subscales showed mean performance around the mid of the scale without ceiling effects. Both tests identified a large proportion of the subjects as cognitive impaired, however, with a substantially larger proportion for the BNIS (89%) compared with the MMSE (65%). We conclude that the BNIS may be a useful screening instrument for cognitive dysfunction after ischemic stroke and that a large proportion of young and middle-aged ischemic stroke survivors showed signs of cognitive dysfunction long after index stroke. Further validations of BNIS against formal neuropsychological testing and studies of the determinants and consequences of long-term cognitive outcome in this patient group are warranted. **Key Words:** BNIS—MMSE—cerebral infarction—cognitive screening—long-term outcome.
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Introduction

For young and middle-aged stroke survivors, cognitive dysfunction is important, having impact on both professional activities and social functioning.[1-3] However, stroke studies rarely include cognitive assessment,[4] and in long-term follow-up, cognitive evaluation is even more infrequent.[5]

The optimal screening test for cognitive dysfunction after stroke should be short, sensitive, and also enable cognitive profiling as the patterns of symptoms are varied

after stroke.[6] The most commonly used screening method, the Mini-Mental State Examination (MMSE),[4] has been criticized in assessment for cognitive dysfunction associated with cerebrovascular disease because it has a pronounced ceiling effect and because it cannot be used to generate a full cognitive profile.[6-8] Different cutoff levels for screening purposes in stroke patients have been suggested after validation against a neuropsychological battery, varying between less than 27 and less than 30.[8-10] Despite this, with the MMSE, cognitive dysfunction after stroke may be underestimated.[6,7] These shortcomings may be especially important for working-age patients, who frequently describe consequences of cognitive dysfunction despite of a low residual neurological deficit.[11]

The Barrow Neurological Institute Screen for Higher Cerebral Functions (BNIS) is a validated test for determining cognitive dysfunction[12-15] that was developed for assessing a broader range of cognitive functions. It has several attributes making it potentially useful as a screening test after ischemic stroke. First, it evaluates a variety of functions often affected following stroke such as memory, attention, and visuospatial problem solving, including executive aspects of working memory, logical inductive thinking, and top-down control. Second, the BNIS has items for affect and awareness, rarely evaluated in screening tests for cognitive dysfunction. Finally, it is easy to administer, only takes 15-20 minutes to perform, and test items are simple to understand. Currently, 1 cutoff level for screening has been suggested for the BNIS; the level of less than 47 (of max 50) was established in American studies[12-15] and was further validated in Swedish studies, showing high sensitivity in identifying patients with various forms of brain dysfunction (including stroke) versus neurological healthy controls.[14,15] However, there is a lack of studies on the applicability of the BNIS in a stroke population.

In this study, we investigated the utility of the BNIS and the MMSE in screening for cognitive dysfunction in a follow-up study 7 years after ischemic stroke in patients being in working age at index stroke.

Materials and Methods

Patients were recruited from the Sahlgrenska Academy Study on Ischemic Stroke (SAHLSIS), the design of which has been reported elsewhere.[16] In brief, patients presenting with a first-ever or recurrent acute ischemic stroke before reaching the age of 70 years were consecutively recruited at 4 stroke units in Western Sweden from 1998 to 2003. Written informed consent was obtained from all participants. For participants who were unable to communicate, consent was obtained from their next of kin.

All participants in SAHLSIS are followed prospectively with respect to survival and recurrent vascular events.[17] In the present study, all surviving patients recruited at the stroke unit at the Sahlgrenska University Hospital (n = 358) were invited to participate in a follow-up, SAHLSIS Outcome, 7 years after their index stroke. The study protocol included 1 visit to a study nurse (I.E.) and 1 visit to a study neurologist (P.R. and L.H.), and a postal questionnaire was distributed to the participants before the study visits. Patients who were unable to visit our clinic were offered a home visit by the study nurse and 1 study neurologist (I.E. and P.R.). The SAHLSIS and SAHLSIS Outcome were approved by the Ethics Committee of the University of Gothenburg.

Cognitive functions were screened using the BNIS[12,15] and the MMSE. The BNIS test comprises a prescreen (level of arousal 3p, basic communication 3p, and cooperation 3p) to evaluate whether the patient is capable to take part in further testing. The total score (maximum 50 points) reflects the overall cognitive function and consists of the result from the prescreen and the 7 subscales (speech and language 15p, orientation 3p, attention/concentration 3p, visual and visuospatial problem solving 8p, memory 7p, affect 4p, and awareness 1p). The items included in each subscale are described in Prigatano and Wong.[18] BNIS was administered by the study nurse at the first visit, whereas MMSE was administered by a study neurologist at the second visit. The study nurse had initial training in administering the BNIS and supervision throughout the study by a neuropsychologist (C.H.). For patients assessed at home visits, both tests were administered at the same session. The cutoff level for screening of possible cognitive dysfunction was less than 47 for the BNIS[13,15] and less than 29 for the MMSE.[10] The latter level was selected to favor high sensitivity for the MMSE as a standard of comparison.

Stroke-related neurological deficit was assessed using the National Institutes of Health Stroke Scale (NIHSS), and functional outcome was assessed using the modified Rankin Scale (mRS). Depression was assessed by the depression subscale of the Hospital Anxiety Depression Scale, with a score of greater than 10 indicating depression.[19] Education was dichotomized according to the norms of the Swedish educational system, so that 9 years of education (compulsory school) or less was classified as "low" and more than 9 years of education as "high."

Statistical Analyses

For comparisons between tested and nontested patients, nonparametric tests were used. The baseline NIHSS score was derived from the Scandinavian Stroke Scale score at inclusion using a mathematic conversion model.[20]

For both the BNIS and the MMSE subscales, mean and median scores, the percent of the maximum possible score, and percent with maximum score were calculated.