Brief Reports

Assessment of a Modified Mini-Mental Scale for Cognitive Functions in Children

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This study was conducted to standardize a clinical test to assess cognitive functions in children between 3-14 years and to evaluate its use in patients with encephalopathy. We included 50 children in Group A with non-neurological illness. Another 50 children were included in Group B with encephalopathy due to varied etiologies. The Mini Mental State Examination (MMSE) used in adults was modified, using tests from standardized assessment tools previously used in Indian children. It was administered independently by two observers at admission and after a few days in the two Groups. In Group A, the mean & SD of the score in various age groups were calculated. Sensitivity and specificity of the test in predicting poor outcome with a cut-off score of 10 was calculated at admission and after a mean of 4 days. The average time taken for the test was 6.03 minutes. No significant interobserver variability was found. Cut off abnormal scores calculated as 2 SD below mean in different age groups were 3-5 years – 24, 6-8 years - 28, 9-11 years – 30, 12-14 years – 35. In children with encephalopathy a score below 10 predicted poor outcome with a sensitivity of 35% and specificity of 100% at admission. Retest after 4 days had sensitivity and specificity of 68% and 100% respectively. We conclude that the modified Child MMSE may be used as a screening test to assess and monitor cognitive functions in children.

Key words: *Mini-mental scale, Children.*

HIGHER mental functions constitute an important part of the clinical evaluation of cortical function. In adults, the Mini-Mental State Examination (MMSE), created in 1975, is a standardized tool to assess mental status; it takes 5-10 minutes to administer and is practical to use repeatedly and routinely(1). However, the MMSE is not designed for use in children. The aim of our study was to develop a scoring system that can quickly assess cognitive impairment in children. We modified the original MMSE and made a similar scoring system that will cover 5 areas of cognitive functions *i.e.*, orientation, attention-concentration, registration, recall and language in a single set of questions for use in children aged between 3-14 years. The test items were chosen from previously standardized scales used in Indian children(2,3).

Subjects and Methods

The study was conducted between January 2003 to June 2003 in children admitted in the pediatric ward of Choithram Hospital and Research Center, Indore, Madhya Pradesh. The test was first performed in 50

neurologically normal children who were admitted with non-neurological illnesses. The test was reperformed on the same day by another examiner. Then the test was repeated by the first examiner after an average of 4 days. In the same way the test was performed in 50 children with varied neurological illnesses. The inclusion criteria were children with documented cortical injury (on CT/MRI) *e.g.*, vascular injury, degenerative brain disease, head injury, brain tumors, hypoxic injury etc. and children with suspected cortical injury *e.g.*, early hepatic encephalopathy, febrile encephalopathy, uremic encephalopathy, metabolic encephalopathy or unexplained encephalopathy. Comatose and mentally retarded were excluded from the study. We developed our score by modifying the original MMSE. The test included 5 subtests for assessment of orientation, attention-concentration, registration, recall and language. The test of assessment of each of these areas were chosen from the Behavioral Assessment Scale for Indian Children with Mental Retardation (BASIC-MR) and Modified Stanford Binet Scale for Indian children to form the final tests(2,3). The tests were chosen if they were simple, quick to perform, understandable irrespective of socio-economic status and education and applicable in an age range from 3 to 14 years. The detailed proforma is listed in *Appendix-1*.

Results

The epidemiological profile of children in Group A and B are given in *Table I.* Average score in Group A was 34/37 (minimum 31, maximum 37) between 3 to 6 years. All children more than 7 years scored 37/37. In Group A there was no statistically significant variation between the scores and socio-economic status using the chi-square test (P >0.5). There was high inter-observer reliability using the Karl Pearson's correlation coefficient. In Group B, the etiologies for cortical injury were as follows - infections 26/50 (52%), trauma 10/50 (20%), metabolic 6/50 (12%), tumors 4/50 (8%) and miscellaneous 4/50 (8%). The localization of lesions based on CT/MRI findings was as follows–diffuse 36%, frontal 8%, parietal 2%, temporal 4%, parieto-occipital 6%, temporo-parietal 8%, fronto-parietal 6%, basal ganglia 6% and cerebellum 6%. In the rest 18 % CT/MRI was not done. Of the 50 patients, 37 (74%) survived, 10 (20%) died and 3 (6%) left against medical advice.

In group A, mean and standard deviation of scores in different age groups are given in *Table II*. Cut off abnormal scores calculated as 2 SD below mean in different age group were 24, 28, 30 and 35 in the age groups 3-5 years, 6-8 years, 9-11 years and 12-14 years respectively. In Group B, the distribution of children with various scores at admission and after an average of 4 days is given in *Table III*. There was a fair correlation between child MMSE and Glassgow coma scale (CC = 0.464, P <0.001). Thirty five per cent of children with a score less then 10 at admission died whereas 100% of children with a score more than 10 survived. However, when the test was repeated on day four, 68% with score less than 10 died while 100% with score more than 10 survived. A score less than 10 predicted poor outcome with a sensitivity of 35% on day one and the sensitivity rose to 68% on day four. The specificity of the test was 100% in both instances. The sensitivity and the specificity of the subtests to predict poor outcome are given in *Table IV*.

Mean scores in various etiologies were calculated and is given in *Table V*. The average time taken for each test was 6.03 minutes (range 5-7 minutes).

Discussion

The MMSE was first developed and

TABLE I–*Epidemiological Profile of Children in Group A and B.*

	Group A	Group B
Number	50	50
Male: Female	2:1	2.3:1
Mean age (In years) (Range 3 to 14 years)	8.1	7.4
Socioeconomic status		
Lower	3 (6%)	9 (18%)
Middle	45 (90%)	40 (80%)
Upper	2 (4%)	1(2%)
Education		
Nursery-KG	6 (12%)	14 (28%)
Std I to V	33 (66%)	28 (56%)
Std VI to X	11 (22%)	8(16%)
Hindi Medium	14 (28%)	30 (60%)
English Medium	36 (72%)	20 (40%)

TABLE II–*Mean and Standard Deviation of Modified Child MMSE Scores in Different Age Groups in Control Group A.*

Age group	Mean	Standard deviation	Score at 2 standard deviation (Approx.)
3-5 years	29	2.34	24
6-8 years	34.72	3.03	28
9-11 years	34.90	2.77	30
12-14 years	36.80	0.63	35

TABLE III–*Distribution of Children with Modified Child MMSE Scores in Study Group B.*

Scores	Score I No. of children	Score III No. of children
0	30 (60%)	10(20%)
1-10	7 (14%)	9(18%)
10-30	8 (16%)	14(28%)
>30	5(10%)	17(34%)

TABLE IV–*Sensitivity and Specificity of Subtests of the Modified Child MMSE.*

Subtest	Sensitivity %	Specificity %
Orientation (Score <5)	54.16	100
Attention & Concentration (Score < 3)	61.9	100
Registration & Sensory Perception (Score < 1)	76.4	100
Recall (Score <1)	76.4	100
Language (Score <1)	68.4	100

Key Messages

- This study attempts to standardize a modified MMSE for use in Indian children
- A score less than 10 on day 4 after therapy has a specificity of 100% and sensitivity of 68% in predicting poor outcome in children with encephalopathy.
- Scores 2 SD below normal for various ages may be used to pick up early encephalopathy.

reported by Folstein, *et al*. in 69 patients in a psychiatric hospital and 63 normal elderly controls(1). The MMSE is a valuable instrument used in adults to screen for cognitive dysfunction, assess severity of impairment and document cognitive changes over time(4). Its importance in clinical medicine is to be able to pick up early encephalopathy or dementia and progressively monitor the patient over time to assess improvement or deterioration. It also gives a standardized single score per patient, which can be used to compare two groups when a particular therapy is being tried. Though the MMSE has been repeatedly tested in various settings in adults(5-7), its use in pediatrics is limited since the score applies to patients above 18 years. There are a few scattered reports of modified MMSE being used in pediatrics(8-0), but no study has been done in Indian children. On the other hand, the Glasgow coma scale has been used in children but its value is limited in picking up fine changes of cognitive dysfunction seen in very early encephalopathy(11).

TABLE V– *Mean Scores of Modified Child MMSE in Various Etiologies.*

Etiology	Mean Score (out of 37)	
	Score 1	Score III
Infections	5.17(13.9%)	13.66 (36.99%)
Trauma	8.5 (22.9%)	25.7(69.4%)
Tumors	16.5 (44.5%)	21.75(58.78%)
Metabolic	14.22 (38.4%)	24.86(67.18%)
Miscellaneous	6.25 (16.89%)	24.75 (66,89%)

The MMSE has 11 questions in 5 categories–Orientation, Attention-Concentration, Registration, Recall and Language. In our test we have stuck to the original categories but chosen tests which can be performed in the pediatric age group from 3 to 14 years. To choose an appropriate test we used tests, which have been earlier standardized in an Indian setting(2,3). The details of the test performa are given in *Appendix-1*. The tests were chosen after deliberation with a trained psychologist regarding its ability to test what it is purporting to test and the ability to be understood by Indian children of various socioeconomic strata and education. In 50 controls the mean score was 34/37 between 3-6 years and a full 37/37 above 7 years. A good correlation was found between child MMSE and Glasgow coma scale using Pearson's correlation coefficient. The Karl Pearson's correlation coefficient of test-retest using two examiners showed good correlation indicating adequate inter observer reliability.

In adults the MMSE cut-off score of 17 has a sensitivity of 81% and specificity of 100% to pick up cognitive dysfunction(12). In our child MMSE a score below 10 on day 4 had a sensitivity of 68% and specificity of 100% to predict poor outcome in children with encephalopathy due to various etiologies. It's sensitivity and specificity to pick up cognitive dysfunction needs to be tested in other settings.

In the Denver Development Scoring Test (DDST) scores 2 SD below mean for various age groups were calculated and used to predict

abnormal deviation in development. Similarly, in our child MMSE, we made cut off scores 2 SD below mean for different ages which can be used to pick up early cognitive dysfunction. In the subtest analysis, registration and sensory perception and recall had highest sensitivity in predicting mortality. In the MMSE the digit symbol subtest has been found to have the highest correlation with total MMSE scores(13). It is interesting to note that lowest scores were found in patients with infective etiology and those with diffuse disease. The average time to administer our test was 6 minutes which is comparable with 5-10 minutes required for the adult MMSE(1).

In summary, we have tried to develop a simple, quick, screening test in children between 3 to 15 years for cognitive dysfunction. It may be used to pick up early encephalopathy and to monitor progression of disease. This child MMSE needs further standardization to be used as a screening test to assess cognitive functions in mentally retarded children also.

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Appendix 1

The Proforma

Functions	Tests	Score I	Score II	Score III
1. Orientation	• Sex/ Name/ Last Name/ Recognizes Relative (One point for each, total score 4)			
	• Place/ City/ State/ Country (One point for each total score 4)			
	• Day/ Date/ Month/ Year (One point for each, total score 4)			
2. Attention and Concentration	• Minimum of 2 and Maximum of 5 digits forward (One point for each, total score4)			
	• Minimum of 2 and Maximum of 4 digits backward (One point for each, total score3)			
3. Registration & Sensory perception	• Identify 3 objects by name (One point for each, total score 3)			
4. Recall	• Tell 3 objects presented previously (One point for each, total score 3)			
5. Language				
• Name Body Parts	• Points to 5 body parts (One point for each, total score 5)			
• Command (Three Step)	• Unwrap the toffee, give the wrapper to the doctor & then eat it (One point for each, total score 3)			
• Repeat Sentence	• Billi doodh peeti hai (total score 1)			
• Reading	• Reads his/ her name (Total score 1)			
• Writing	• Writes own name (Total score 1)			
• Copy a design	• ◯ (Total score 1)			
Total score				