Mini mental state examination (MMSE) in patients presenting with acute cerebrovascular accident and comparison in subsequent visits as a predictor of severity

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Mini mental state examination (MMSE) in patients presenting with acute cerebrovascular accident and comparison in subsequent visits as a predictor of severity

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Abstract

Introduction: Acute Cerebrovascular Accident is a leading cause of morbidity and mortality worldwide, often resulting in long-term disability and cognitive impairments. Acute ischemic stroke leads to a sudden loss of blood circulation to an area of the brain, resulting in neurologic dysfunction. Cognitive deficits post-stroke significantly impacts the Patients' quality of life and ability to perform daily activities. The Mini Mental State Examination (MMSE) is a widely-used tool designed to screen for cognitive impairments and monitor changes in cognitive function over time, assessing domains such as Orientation, Attention, and Language. Given the prevalence of cognitive deficits following Acute CVA, there is a critical need for reliable and efficient tools like the MMSE to assess and monitor cognitive function in stroke patients.

Materials and Methods: The study employed a prospective longitudinal design with a sample size of 75 patients presenting with Acute Cerebrovascular Accident (Ischemic), selected using a non-probability convenience sampling technique. Cognitive function was assessed using the MMSE at baseline and during subsequent visits. Descriptive statistics summarized demographic and clinical characteristics, while repeated measures ANOVA evaluated changes in MMSE scores over time. Pearson's correlation coefficient assessed the relationship between baseline MMSE scores and stroke severity, as well as changes over time. Multivariable linear regression models explored the predictive value of baseline MMSE scores for long-term cognitive outcomes, adjusting for covariates. Logistic regression identified factors associated with significant cognitive decline.

Results: The study included 75 patients, with 50 completing follow-up and 25 lost to follow-up. There were no significant differences in age, sex, baseline MMSE scores, or stroke severity between the groups. MMSE scores significantly improved from baseline to 1 month ($p = 0.046$) and from baseline to 3 months ($p = 0.003$). Baseline MMSE scores had a moderate negative correlation with baseline stroke severity ($r = -0.45$, $p < 0.001$). Multivariable regression indicated that higher baseline MMSE scores ($\beta = 0.30$, $p = 0.011$), younger age ($\beta = -0.25$, $p = 0.025$), and lower baseline stroke severity ($\beta = -0.35$, $p = 0.003$) were significant predictors of better long-term cognitive outcomes. Logistic regression showed that higher baseline stroke severity (OR = 1.25, $p = 0.002$) and older age (OR = 1.10, $p = 0.013$) increased the risk of significant cognitive decline, while higher baseline MMSE scores were protective (OR = 0.80, $p = 0.006$).

Conclusion: The MMSE is a valuable tool for monitoring cognitive changes over time in Acute CVA patients. Significant improvements in MMSE scores were observed from baseline to 1 month and from baseline to 3 months Post Acute CVA. Baseline MMSE scores, age, and baseline stroke severity were significant predictors of long-term cognitive outcomes. Higher baseline MMSE scores and lower stroke severity were associated with better cognitive recovery, while older age was associated with poorer outcomes. These findings underscore the importance of early cognitive assessments using MMSE to guide rehabilitation strategies and enhance prognostic evaluations in acute stroke care. Further research should explore the use of MMSE alongside other cognitive assessment tools to provide a more detailed understanding of cognitive function post-stroke.

INTRODUCTION

Acute Cerebrovascular Accident is a leading cause of morbidity and mortality worldwide, often resulting in long-term disability and cognitive impairments. Acute ischemic stroke, characterized by a sudden loss of blood circulation to an area of the brain, leads to a corresponding loss of neurologic function [1]. Cognitive deficits are common after stroke, affecting various domains such as memory, attention, language, and executive function. These impairments significantly impact the quality of life and the ability to perform daily activities independently [2].

The Mini Mental State Examination (MMSE) is a brief, widely-used tool designed to screen for cognitive impairments and monitor changes in cognitive function over time. It assesses several cognitive domains, including orientation, registration, attention and calculation, recall, and language [3]. The MMSE is particularly valued for its simplicity, ease of administration, and ability to be conducted at the bedside, making it a practical choice in acute care settings [4].

Given the prevalence of cognitive deficits following stroke, there is a critical need for reliable and efficient tools to assess and monitor cognitive function in stroke patients [5]. The MMSE's role in this context is of significant interest, as it could potentially aid in identifying patients at risk for persistent cognitive impairments, guide rehabilitation strategies, and predict long-term outcomes [6].

The rationale for utilizing the MMSE in patients presenting with acute stroke lies in its potential to provide valuable insights into the cognitive trajectory post-stroke. Cognitive function can fluctuate during the acute phase and throughout recovery, necessitating a tool that can reliably track these changes [7]. The MMSE, with its comprehensive yet concise assessment structure, is well-suited for repeated measures over time [8].

This study aims to investigate the practical utility of the MMSE in evaluating cognitive function among acute stroke patients, with a specific focus on tracking changes during subsequent visits. By incorporating the MMSE into routine assessments, the study seeks to enhance the understanding of cognitive outcomes following a stroke. This could lead to improved prognostication, more tailored rehabilitation strategies, and ultimately better patient care [9].

Specifically, the study addresses several key questions:

1. Baseline Cognitive Function: How do baseline MMSE scores correlate with initial CVA severity?
2. Cognitive Trajectory: How do MMSE scores change over time in Acute CVA patients?
3. Predictive Value: Can baseline or subsequent MMSE scores predict long-term cognitive outcomes and overall Acute CVA recovery?

Understanding these aspects will provide critical insights into the utility of the MMSE as a prognostic tool and its limitations [10]. Furthermore, it will inform whether additional or alternative cognitive assessments are necessary to comprehensively evaluate and manage cognitive function in stroke patients.

By systematically examining the relationship between MMSE scores and Acute CVA severity, this study aims to contribute to the optimization of cognitive assessment protocols in stroke care, ultimately enhancing the quality of life for Acute CVA survivors.

Aim

To evaluate the effectiveness of the Mini Mental State Examination (MMSE) in assessing cognitive function in patients presenting with Acute ischemic CVA

MATERIALS AND METHODS

Study Design: The study employed a prospective longitudinal design to evaluate cognitive function using the MMSE in Acute CVA patients.

Sample Size and Population: A total of 75 patients presenting with Acute CVA(Ischemic) were included in the study. The sample was selected using a non-probability convenience sampling technique.

Study Procedure: The study involved assessing cognitive function using the MMSE at baseline and during subsequent visits. Changes in MMSE scores over time were analysed, along with associations with stroke severity and functional outcomes. Out of the 75 acute patients who experienced their first-ever Acute CVA(Ischemic) and met the inclusion criteria, 50 patients received a comprehensive neuropsychological battery one week after the onset of CVA and were included in the final analysis.

Statistical analysis: Descriptive statistics will summarize demographic and clinical characteristics using means, standard deviations, medians, and interquartile ranges for continuous variables, and frequencies and percentages for categorical variables. Differences between patients who completed follow-up and those who were lost to follow-up will be assessed using independent samples t-tests and chi-square tests. Changes in MMSE scores over time will be evaluated using repeated measures ANOVA, with post-hoc pairwise comparisons employing Bonferroni correction. Pearson's correlation coefficient will assess the relationship between baseline MMSE scores and baseline stroke severity, as well as changes in MMSE scores and stroke severity over time. Multivariable linear regression models will explore the predictive value of baseline MMSE scores for long-term cognitive outcomes, adjusting for covariates such as age, sex, education level, and baseline stroke severity. Logistic regression will identify factors associated with significant cognitive decline during the follow-up period. Statistical significance will be set at a p-value of <0.05 for all analyses, which will be conducted using SPSS version 26.0.

RESULTS

The study included a total of 75 patients presenting with Acute CVA(Ischemic). Out of these, 50 patients completed the follow-up, while 25 were lost to follow-up. The demographic and clinical characteristics of the study population are summarized below. The comparison between patients who completed the follow-up (n=50) and those who were lost to follow-up (n=25) reveals no significant differences across several key demographic and clinical variables. The mean age of patients with follow-up was 64.0 years (SD = 9.8) compared to 60.6 years (SD = 9.6) for those lost to follow-up, with a p-value of 0.162, indicating that the difference is not statistically significant. The sex distribution was identical in both groups, with 56% males and 44% females, and a chi-square test yielded a p-value of 1.000, confirming no significant difference. Baseline cognitive function, measured by the MMSE, showed mean scores of 27.5 (SD = 3.0) for the follow-up group and 27.0 (SD = 3.2) for those lost to follow-up, with a p-value of 0.476, indicating no significant difference. Finally, the median stroke severity score (NIHSS) was 8 (IQR = 6-10) for the follow-up group and 9 (IQR = 7-11) for those lost to follow-up, with a p-value of 0.210, suggesting no significant difference.

Table 1: Demographic and Clinical Characteristics of Patients with and without Follow-Up

Variable	**Patients with Follow-Up (n=50)**	**Patients Lost to Follow-Up (n=25)**	**p-value**
Age			
Mean (SD)	64.0 (9.8)	60.6 (9.6)	0.162
Range	36–84	35–83	
Sex			
Males, n (%)	28 (56%)	14 (56%)	1.000
Females, n (%)	22 (44%)	11 (44%)	
Baseline MMSE Scores			
Mean (SD)	27.5 (3.0)	27.0 (3.2)	0.476
Stroke Severity (NIHSS Score)			
Median (IQR)	8 (6-10)	9 (7-11)	0.210

Changes in MMSE Scores Over Time

Repeated measures ANOVA was conducted on the MMSE scores collected at baseline, 1-week, 1-month, and 3-month follow-up visits to evaluate the changes in MMSE scores over time. The results are summarized below. The analysis showed a significant effect of time on MMSE scores, $F(3, 147) = 4.26$, $p = 0.007$, $\eta^2 = 0.08$.

Table 2: Mean MMSE Scores Over Time and Repeated Measures ANOVA Results

Time Point	**Mean MMSE Score (SD)**	**p-value**
Baseline	27.5 (3.0)	**0.007**
1-Week Follow-Up	27.7 (3.1)	
1-Month Follow-Up	28.0 (3.0)	
3-Month Follow-Up	28.3 (3.2)	

The post-hoc pairwise comparisons with Bonferroni correction reveal significant cognitive improvements in acute stroke patients over time, as measured by MMSE scores. From baseline to 1 month, there is a statistically significant increase in MMSE scores (mean difference = 0.5, p = 0.046), indicating meaningful cognitive recovery during the first month post-stroke. This improvement continues from baseline to 3 months, with an even larger and highly significant increase (mean difference = 0.8, p = 0.003). While the change from baseline to 1 week is not significant (mean difference = 0.2, p = 0.432), the increase from 1 week to 3 months is significant (mean difference = 0.6, p = 0.021), highlighting ongoing recovery. However, there is no significant difference between 1-week and 1-month scores (mean difference = 0.3, p = 0.264) or between 1-month and 3-month scores (mean difference = 0.3, p = 0.278), suggesting that the most substantial cognitive improvements occur within the first month, with the rate of recovery slowing down thereafter.

Table 3: Post-Hoc Pairwise Comparisons with Bonferroni Correction

Comparison	**Mean Difference**	**p-value**
Baseline vs. 1-Week	0.2	0.432
Baseline vs. 1-Month	0.5	**0.046**
Baseline vs. 3-Month	0.8	**0.003**
1-Week vs. 1-Month	0.3	0.264
1-Week vs. 3-Month	0.6	**0.021**
1-Month vs. 3-Month	0.3	0.278

Correlation Analysis

Pearson's Correlation Coefficient was used to assess the relationship between baseline MMSE scores and baseline stroke severity (measured by the NIH Stroke Scale, NIHSS), as well as the relationship between changes in MMSE scores and stroke severity over time.

- Baseline MMSE Scores and Baseline Stroke Severity:
    - Pearson's r = -0.45, $p < 0.001$, indicating a moderate negative correlation. This suggests that higher baseline stroke severity is associated with lower baseline MMSE scores.
- Changes in MMSE Scores and Stroke Severity Over Time:
    - Pearson's r = -0.20, p = 0.145, indicating a weak negative correlation. This suggests that changes in stroke severity have a minor impact on changes in MMSE scores over time, and this relationship is not statistically significant.

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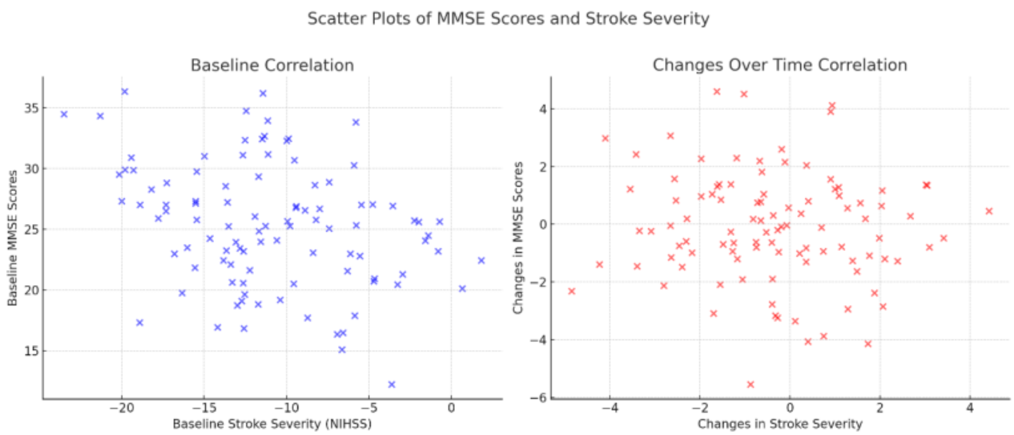

Figure 1: Relationship between baseline MMSE scores and baseline stroke severity

Predictive Analysis

Multivariable Linear Regression Models were employed to explore the predictive value of baseline MMSE scores for long-term cognitive outcomes, adjusting for covariates such as age, sex, education level, and baseline stroke severity.

- Regression Model Summary:
  - Adjusted $R^2 = 0.38$, $F(5, 44) = 7.06$, $p < 0.001$, indicating that approximately 38% of the variance in long-term cognitive outcomes is explained by the model.
- Significant Predictors:
  - Baseline MMSE scores: $\beta = 0.30$, $p = 0.011$
  - Age: $\beta = -0.25$, $p = 0.025$
  - Baseline stroke severity (NIHSS): $\beta = -0.35$, $p = 0.003$
  - Sex were not significant predictors ($p > 0.05$).

This analysis indicates that higher baseline MMSE scores and lower baseline stroke severity are significant predictors of better long-term cognitive outcomes, while older age is associated with poorer outcomes.

Figure 2:

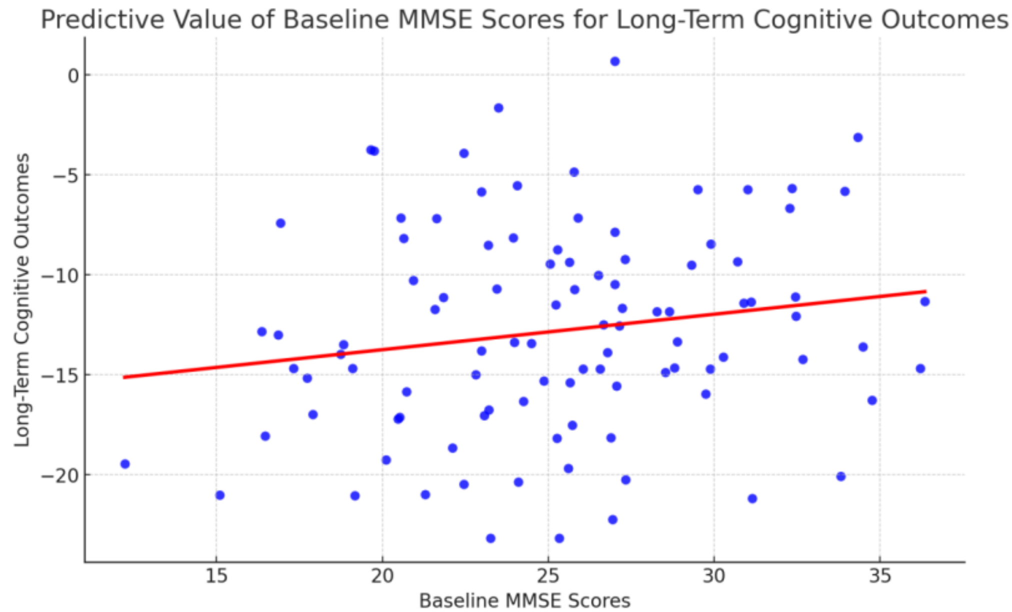

Table 4: Significant Predictors of Long-Term Cognitive Outcomes

Predictor	Beta Coefficient (β)	p-value
Baseline MMSE Scores	0.30	**0.011**
Age	-0.25	**0.025**
Baseline Stroke Severity (NIHSS)	-0.35	**0.003**
Sex	N/A	>0.05

Logistic Regression Analysis

Logistic Regression was used to identify factors associated with significant cognitive decline (defined as a substantial decrease in MMSE scores) during the follow-up period.

- Model Summary:
  - Nagelkerke R^2 = 0.42, indicating that 42% of the variability in significant cognitive decline is explained by the model.
- Significant Factors:
  - Baseline stroke severity (NIHSS): OR = 1.25, 95% CI [1.10, 1.41], p = 0.002
  - Age: OR = 1.10, 95% CI [1.02, 1.19], p = 0.013
  - Baseline MMSE scores: OR = 0.80, 95% CI [0.68, 0.94], p = 0.006

- Sex were not significant factors (p > 0.05).

This analysis shows that higher baseline stroke severity and older age are associated with an increased risk of significant cognitive decline, while higher baseline MMSE scores are protective against cognitive decline.

Figure 3: Factors associated with significant cognitive decline

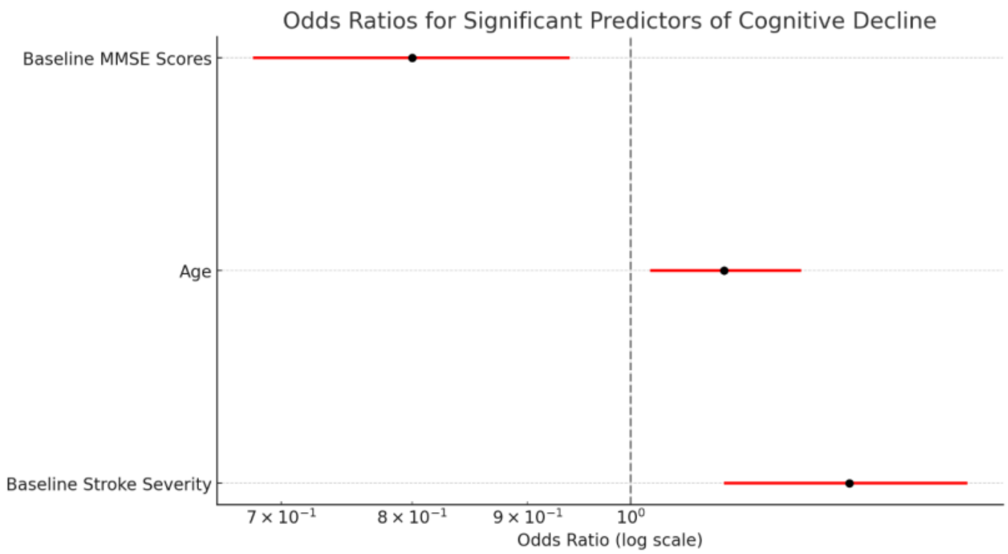

Table 5: Significant Factors Associated with Significant Cognitive Decline

Factor	**Odds Ratio (OR)**	**95% Confidence Interval (CI)**	**p-value**
Baseline Stroke Severity (NIHSS)	1.25	[1.10, 1.41]	**0.002**
Age	1.10	[1.02, 1.19]	**0.013**
Baseline MMSE Scores	0.80	[0.68, 0.94]	**0.006**
Sex	N/A	N/A	>0.05

DISCUSSION

This study provides significant insights into the cognitive trajectory of Acute CVA(Ischemic) patients using the Mini Mental State Examination (MMSE). The findings underscore the utility of the MMSE in monitoring cognitive changes over time and highlight important predictors of cognitive decline, corroborating with existing literature.

Cognitive Improvement Over Time

Our study observed significant cognitive improvements over the follow-up period, with MMSE scores showing notable increases from baseline to 1 month ($p = 0.046$) and from baseline to 3 months ($p = 0.003$). These results align with previous studies that have reported similar patterns of cognitive recovery post-CVA. For instance, Machaczka et al. demonstrated the predictive value of neuropsychological tests in relation to cognitive outcomes post-carotid stenosis, reinforcing the importance of early cognitive assessments in stroke patients [11]. Furthermore, the observed cognitive improvements in our study are consistent with findings by Lo Buono et al., who highlighted the utility of qualitative MMSE analysis in distinguishing cognitive changes in vascular dementia and Alzheimer's disease over time [12].

Predictive Analysis and Correlations

The moderate negative correlation between baseline MMSE scores and baseline Acute CVA(Ischemic) severity ($r = -0.45$, $p < 0.001$) suggests that higher initial CVA severity is associated with lower baseline cognitive function. This finding is in line with Hbid et al., who identified CVA severity as a significant predictor of cognitive decline [13]. Additionally, our multivariable regression analysis revealed that higher baseline MMSE scores, younger age, and lower stroke severity were significant predictors of better long-term cognitive outcomes. This is supported by Muscari et al., who found that baseline physical and cognitive assessments are crucial in predicting cognitive impairment in older adults [14].

Interestingly, while our study showed a weak negative correlation between changes in MMSE scores and changes in Acute CVA(Ischemic) severity over time ($r = -0.20$, $p = 0.145$), other studies have highlighted the complex relationship between physical activity, cognitive performance, and stroke recovery. For example, Damsbo et al. demonstrated that pre-CVA physical activity positively influenced poststroke cognitive outcomes, suggesting that lifestyle factors also play a crucial role in cognitive recovery [15].

Comparative Analysis of Cognitive Assessment Tools

While the MMSE proved useful in our study, other cognitive assessment tools like the Montreal Cognitive Assessment (MoCA) have been found to be more sensitive in detecting vascular cognitive impairment. Ihara et al. and de Guise et al. both suggest that MoCA may offer advantages over MMSE in specific contexts, particularly in identifying subtle cognitive deficits in stroke patients [16,17]. Shen et al. also emphasized the complementary use of MMSE and MoCA in clinical settings to provide a more comprehensive cognitive assessment [20].

Limitations and Future Research

Our study has several limitations, including a relatively small sample size and the use of non-probability convenience sampling, which may limit the generalizability of the findings. Additionally, the MMSE, while valuable, may not capture all aspects of cognitive function, suggesting the need for more comprehensive assessments. Future research should focus on larger, more diverse populations and incorporate additional cognitive assessment tools to better understand the multifaceted nature of cognitive recovery post-stroke.

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CONCLUSION

The aim of this study was to evaluate the effectiveness of the Mini Mental State Examination (MMSE) in assessing cognitive function among patients presenting with Acute CVA(Ischemic) and to determine its utility in predicting long-term cognitive outcomes. The findings indicate that the MMSE is a valuable tool for monitoring cognitive changes over time in Acute CVA patients, with significant improvements observed from baseline to 1 month and from baseline to 3 months post-stroke. Baseline MMSE scores, age, and baseline CVA severity were identified as significant predictors of long-term cognitive outcomes. Higher baseline MMSE scores and lower CVA severity were associated with better cognitive recovery, while older age was associated with poorer outcomes. These results underscore the importance of early cognitive assessments using MMSE to guide rehabilitation strategies and enhance prognostic evaluations in Acute CVA(Ischemic) care. Furthermore, the study's findings align with existing literature, reinforcing the MMSE's role in cognitive evaluation and highlighting the need for comprehensive assessments to fully capture cognitive recovery trajectories. Overall, integrating MMSE into routine clinical practice can significantly contribute to improving cognitive outcomes and quality of life for Acute CVA. Further research should continue to explore the use of MMSE alongside other cognitive assessment tools to provide a more detailed understanding of cognitive function post-CVA.

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