Comparison of the Saint Louis University Mental Status Examination and the Mini-Mental State Examination for Detecting Dementia and Mild Neurocognitive Disorder—A Pilot Study

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Context: *The Mini-Mental State Examination (MMSE) is commonly used as a screening tool to detect dementia. However, it performs poorly in identifying persons with mild neurocognitive disorder. The Saint Louis University Mental Status (SLUMS) examination is a 30-point screening questionnaire that tests for orientation, memory, attention, and executive functions.* **Objective:** *The objective of this study was to compare SLUMS and the MMSE for detecting dementia and mild neurocognitive disorder (MNCD) using Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM–IV) criteria.* **Methods:** *Patients at the Veterans' Affairs Geriatric Research, Education and Clinical Center, St. Louis, MO (N = 702) were clinically classified as having normal cognitive functioning, MNCD, or dementia based on DSM–IV criteria. The SLUMS and MMSE were administered for comparison.* **Results:** *Mean age was 75.3 years (standard deviation: 5.5). Regarding education, 62.4% of the sample had at least completed high school and 30.6% had not. Sensitivity and specificity were calculated and receiver operator curves (ROCs) generated for SLUMS and MMSE as a function of diagnosis (MCND versus dementia) and education. Both the SLUMS and MMSE produced acceptable ROCs for the diagnosis of dementia,* but *the ROCs for SLUMS were better than the MMSE for the diagnosis of MNCD in both education groups.* **Conclusion:** *These results suggest that the SLUMS and MMSE have comparable sensitivities, specificities, and area under the curve in detecting dementia. Although the definition of MNCD is controversial, the authors believe that the SLUMS is possibly better at detecting mild neurocognitive disorder, which the MMSE failed to detect, but this needs to be further investigated.* (Am J Geriatr Psychiatry 2006; 14:900–910)

Key Words: SLUMS-a new screening tool, dementia, mild neurocognitive disorder

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The aging of the U.S. population has been accompanied by a dramatic increase in the prevalence of dementia. Dementia is seen in 3%–11% of persons older than 65 years of age and 25%–47% of those older than 85 years of age.[1–5] In 1997, there were 2.3 million persons with Alzheimer disease (AD) in the United States and 90% were 60 years of age or older.[6] Dementia causes a high burden of suffering for patients, their families, and society.[7–11] The annual cost of dementia is approximately $100 billion.[2,7] Nevertheless, dementia is underdiagnosed as evidenced by the fact that 50% of persons with dementia, including mild to moderate forms of dementia, have never received the diagnosis of dementia from their physician.[12–15]

A transitional period exists between normal aging and the diagnosis of clinical probable early AD. This transitional zone is described using a variety of terms such as mild neurocognitive impairment (MCI), dementia prodrome, incipient dementia, isolated memory impairment, and the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM–IV*) construct is called mild neurocognitive disorder. Currently, there is no agreed-on definition of this transitional state. The criterion for mild neurocognitive disorder as defined by *DSM–IV* is shown in Table 1. Similarly, Petersen has defined mild cognitive impairment criteria, which consist of memory complaints usually corroborated by an informant, objective memory impairment for age, essentially preserved general cognitive function, largely intact functional activities, and being not demented.[16,17] In this article, we use mild neurocognitive disorder (MNCD) instead of MCI because we used *DSM–IV* criteria for diagnostic purposes. The diagnostic criterion for dementia of Alzheimer type as defined by *DSM–IV* is shown in Table 2. Similar criteria for other dementias were used as defined by *DSM–IV*.

A number of studies have addressed the conversion of this transitional state of mild neurocognitive disorder or mild cognitive impairment to dementia using different criteria. In the Mayo Clinic's longitudinal studies of aging and dementia in community-dwelling older adults, those who met the criteria for mild cognitive impairment were diagnosed using the following: Mini-Mental State Examination, WAIS–Revised, Wechsler Memory Scale–Revised, Dementia Rating Scale, Free and Cued Selective Reminding Test, and Auditory Verbal Learning Test. Clinical classifications of dementia and AD were determined according to the *Diagnostic and Statistical Manual of Mental Disorders, Revised Third Edition* and the National Institute of Neurological and Communicative Disorders and Stroke–Alzheimer's Disease and Related Disorders Association criteria, respectively, were converted to AD at a rate of 12% per year over the course of 4 years.[18] Similarly, in a Canadian study (using a research battery of neuropsychologic tests), 28% of 107 subjects with memory impairment without dementia converted to AD over a 2-year period, for an annual conversion rate of 14%.[19,20] Other studies using similar methodology in older patients with "questionable dementia," "memory impairment," and "mild cognitive impairment" have reported annual conversion rates to dementia of between 6% and 25%, with a mean conversion rate of approximately 14% across studies.[21–24] Thus, early detection of mild cognitive impairment with proactive treatment has the potential to delay the onset of AD in vulnerable populations in the future.

Given the importance of the detection of mild neurocognitive disorder, a simple, efficient, and sensitive/specific screening tool for this diagnosis is

TABLE 1. ***Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*** **Research Criteria for Mild Neurocognitive Disorder**

A. The presence of two (or more) of the following impairments in cognitive functioning lasting most of the time for a period of 2 weeks (as reported by the individual or a reliable informant):
   1) Memory impairment as identified by a reduced ability to learn or recall information;
   2) Disturbances in executive functioning (i.e., planning, organizing, sequencing, abstracting);
   3) Disturbances in attention or speed of information processing;
   4) Impairment in perceptual–motor abilities; and
   5) Impairment in language (e.g., comprehension, word finding).

B. There is objective evidence from physical examination or laboratory findings (including neuroimaging) or general medical condition that is judged to be etiologically related to the cognitive disturbance.

C. There is evidence from neuropsychologic testing or quantified cognitive assessment of an abnormality or decline in performance.

D. The cognitive deficits causes marked distress or impairment in social, occupational, or other important areas of functioning and represent a decline from a previous level of functioning.

E. The cognitive disturbance does not meet criteria for delirium, a dementia, or an amnestic disorder and is not better accounted for by another mental disorder (e.g., a substance-related disorder, major depressive disorder).

TABLE 2. ***Diagnostic Statistical Manual of Mental Disorders, Fourth Edition*** **Diagnostic Criteria for Dementia of Alzheimer Type**

A. The development of multiple cognitive deficits manifested by both:
   1. Memory impairment(impaired ability to learn new information and to recall previously learned information); and
   2. One (or more) of the following cognitive disturbances:
      a. Aphasia(language disturbances);
      b. Apraxia (impaired ability to carry out motor activities despite intact motor function);
      c. Agnosia (failure to recognize or identify objects despite intact sensory function); and
      d. Disturbance in executive functioning (i.e., planning, organizing, sequencing, abstracting).

B. The cognitive disturbance in criteria A1 and A2 each causes significant impairment in social or occupational functioning and represents a significant decline from previous level of functioning.

C. The course is characterized by gradual onset and continuing cognitive decline.

D. The cognitive deficits in criteria A1 and A2 are not the result of any of the following:
   1. Other central nervous system conditions that may cause progressive deficit in memory and cognition (e.g., cerebrovascular disease, Parkinson disease, Huntington disease, subdural hematoma, normal-pressure hydrocephalus, brain tumor);
   2. Systemic conditions that may cause dementia (e.g., hypothyroidism, vitamin B12 deficiency, niacin deficiency, hypercalcemia, neurosyphilis, HIV infection); or
   3. Substance-induced conditions.

E. The deficit does not occur exclusively during the course of delirium.

F. The disturbance is not better accounted for by another axis I disorder (e.g., major depression disorder, schizophrenia).

clearly needed, particularly for use in primary care. The Mini-Mental State Examination (MMSE)[25] is widely used in practice as a screening tool for dementia. The MMSE has limitations, however, especially with regard to its use in more educated patients and as a screen for mild neurocognitive disorder.[26–28] The Saint Louis University Mental Status Examination (SLUMS) was developed to address this limitation. The SLUMS is a 30-point, 11-item, clinician-administered scale that is similar in format to the MMSE.[29] The SLUMS, however, supplements the MMSE with enhanced tasks corresponding to attention, numeric calculation, immediate and delayed recall, animal naming, digit span, clock drawing, figure recognition/size differentiation, and immediate recall of facts from a paragraph. In particular, the clock drawing test is designed to assess impairment in executive function,[30] one of the earliest forms of cognition affected in mild neurocognitive disorder and dementia. The SLUMS also eliminates some tasks that appear on the MMSE, including repetition and construction. By enhancing the SLUMS relative to the MMSE, it was predicted that the SLUMS would be more sensitive and specific than the MMSE, particularly for diagnoses of mild neurocognitive disorder. In the present study, the SLUMS examination is compared with the MMSE regarding sensitivity/specificity for mild neurocognitive disorder and dementia in a large sample of Veterans' Administration patients. The Saint Louis University Mental Status Examination is shown in Figure 1.

METHODS

Seven hundred five participants in this study were recruited prospectively from January 2003 to September 2003 at the Geriatric Research Education and Clinical Center (GRECC), Veterans' Affairs Medical Center (VAMC) hospitals in Saint Louis, MO. The recruitment process was conducted during a routine clinic visit in which participants were informed about the screening tests and consented as required by the Institutional Review Board of the Saint Louis VAMC. The investigators evaluated each participant during a routine clinic visit and, in addition, a history was obtained from corroborating sources. In addition, a complete physical and mental status examination was performed and laboratory findings were reviewed.[31,32] The investigators used *DSM–IV* criteria to make the diagnosis of mild neurocognitive disorder or dementia. The investigators then completed the MMSE[24] and SLUMS.[28] Those who did not qualify by any of *DSM–IV* criteria were considered having normal cognition or no cognitive problems without considering the scores of MMSE or SLUMS. The inclusion criteria for the study was that the participant should be 60 years of age or older and must consent for the screening tests. The exclusion criteria was refusal or to be unable to complete the screening tests for any reason.

Data Analysis

Statistical analyses were conducted using a statistical software package (SPSS 11.0; SPSS Inc., Chicago, IL). Demographic data were summarized using de-

FIGURE 1. Saint Louis University Mental Status Examination

Saint Louis University
Mental Status (SLUMS) Examination

Name _____ Age _____
Is patient alert? _____ Level of education _____

__/1 ❶ **1. What day of the week is it?**
__/1 ❶ **2. What is the year?**
__/1 ❶ **3. What state are we in?**

4. Please remember these five objects. I will ask you what they are later.
Apple Pen Tie House Car

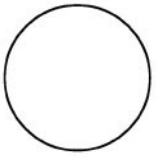
5. You have $100 and you go to the store and buy a dozen apples for $3 and a tricycle for $20.
❶ **How much did you spend?**
__/3 ❷ **How much do you have left?**

6. Please name as many animals as you can in one minute.
__/3 ❶ 0-4 animals ❶ 5-9 animals ❷ 10-14 animals ❸ 15+ animals

__/5 **7. What were the five objects I asked you to remember?** 1 point for each one correct.

8. I am going to give you a series of numbers and I would like you to give them to me backwards. For example, if I say 42, you would say 24.
__/2 ❶ 87 ❶ 649 ❶ 8537

9. This is a clock face. Please put in the hour markers and the time at ten minutes to eleven o'clock.



❷ Hour markers okay
__/4 ❷ Time correct

__/2 ❶ **10. Please place an X in the triangle.**

❶ **Which of the above figures is largest?**

11. I am going to tell you a story. Please listen carefully because afterwards, I'm going to ask you some questions about it.
Jill was a very successful stockbroker. She made a lot of money on the stock market. She then met Jack, a devastatingly handsome man. She married him and had three children. They lived in Chicago. She then stopped work and stayed at home to bring up her children. When they were teenagers, she went back to work. She and Jack lived happily ever after.

__/8 ❷ **What was the female's name?** ❷ **What work did she do?**
❷ **When did she go back to work?** ❷ **What state did she live in?**

_____ **TOTAL SCORE**

Department of Veterans Affairs

SAINT LOUIS UNIVERSITY

AGING SUCCESSFULLY

SCORING		
HIGH SCHOOL EDUCATION		LESS THAN HIGH SCHOOL EDUCATION
27-30	Normal	25-30
21-26	MNCD*	20-24
1-20	Dementia	1-19

*MNCD=Mild neurocognitive disorder

scriptive statistics. Using the standard approach, sensitivity, specificity, and positive and negative predictive values were calculated for various cutoff scores of the SLUMS and the MMSE as a function of diagnoses of mild neurocognitive disorder and dementia (against normal) for patients with less than high school education and those with high school education or more. Standard receiver operator curves (ROCs) were plotted using sensitivity and 1-specificity values. Area under the curve (AUC) was estimated from the ROCs and evaluated for statistical significance using the nonparametric method. The latter method uses the trapezoidal rule for calculating area.[36] The obtained AUC is evaluated for statistical significance against the null hypothesis that the true AUC is 0.50. The significance test used in SPSS is the equivalent of the nonparametric Wilcoxon statistic.[36]

RESULTS

The mean age of the sample was 75.3 years (standard deviation [SD]: 5.5). Patients were classified by education into those with less than a high school education (N = 216 [30.6%]) and those with a high school education or more (N = 489 [69.4%]). With respect to cognitive status, 440 of the patients (62.4%) had normal cognitive functioning by *DSM–IV* criteria, 180 (25.5%) were diagnosed with mild neurocognitive disorder, and 82 (11.6%) were diagnosed with dementia (N = 73 AD; N = 7 vascular dementia; N = 2 other dementia). Three patients (0.4%) were blind and, therefore, a valid cognitive status score could not be obtained using the study measures and were excluded from the final analysis. The SLUMS examination required a mean of 7 minutes (SD: 3) to complete. Table 3 displays the mean age, SLUMS score, and MMSE score for each patient group as a function of education and cognitive status. Using analysis of variance and the Student-Newman-Keuls post hoc test for multiple mean comparisons, demented patients across both education groups were found to be significantly older compared with those with normal and mild neurocognitive disorder ($F2,696 = 22.9$, $p < 0.001$).

Sensitivity and Specificity

Tables 4 through 7 display the cutoff scores for the SLUMS and the MMSE for various levels of sensitivity and specificity as a function of education and cognitive status. The optimal cutoff scores for SLUMS for MNCD with less than high school education and high school or higher education were 23.5 and 25.5, respectively. The cutoff scores for SLUMS for dementia were 19.5 and 21.5 for less than high school education and high school or higher education, respectively. The optimal cutoff score for MMSE for MNCD with less than high school education and high school education or higher were 28.5 and 29.5, respectively. The cutoff scores for MMSE for dementia were 26.5 and 27.5 for less than high school education and high school or higher education, respectively.

Receiver operator curves were calculated from sensitivity and 1-specificity values for the SLUMS and the MMSE for diagnoses of mild neurocognitive disorder and dementia (against normal) for patients with less than high school education and those with high school education or more. Area under the curve was estimated using the Wilcoxon method. Figures 2 and 3 contrast the AUCs for the SLUMS and MMSE for patients with MNCD and those with dementia with less than high school education. As shown in Figure 2, for patients with less than high school

TABLE 3. Descriptive Data by Education and Cognitive Status (*DSM–IV*)

	Less Than High School			High School or More		
	Normal (N = 137)	MNCD (N = 50)	Dementia (N = 27)	Normal (N = 303)	MNCD (N = 130)	Dementia (N = 55)
Age, mean (SD)	74.6 (5.2)	77.8 (6.0)	79.1 (6.7)	74.2 (5.0)	75.6 (5.6)	77.8 (5.1)
SLUMS, mean (SD)	25.7 (2.8)	20.2 (2.4)	11.3 (5.1)	26.9 (2.0)	22.3 (2.1)	14.9 (5.2)
MMSE, mean (SD)	28.6 (1.7)	27.3 (2.4)	21.0 (7.4)	29.0 (1.3)	28.2 (1.7)	23.0 (5.0)

MNCD: mild neurocognitive disorder; SD: standard deviation; SLUMS: St. Louis University Mental Status examination; MMSE: Mini-Mental Status Examination.

TABLE 4. Cutoff Scores for Mild Neurocognitive Impairment (MNCD) in Patients With Less Than High School Education

Test/Category	Cutoff Score (≤)	Sensitivity	Specificity	PPV	NPV
SLUMS/MNCD	19.5	0.40	0.98	0.91	0.82
	20.5	0.56	0.96	0.82	0.86
	21.5	0.70	0.91	0.74	0.89
	22.5	0.78	0.86	0.67	0.91
	23.5	0.92	0.81	0.64	0.97
	24.5	0.96	0.74	0.57	0.98
	25.5	1.00	0.55	0.45	1.00
	26.5	1.00	0.40	0.38	1.00
	27.5	1.00	0.29	0.34	1.00
MMSE/MNCD	21.0	0.02	1.00	1.0	0.74
	22.5	0.04	1.00	1.0	0.74
	23.5	0.04	0.99	0.75	0.74
	24.5	0.20	0.96	0.62	0.77
	25.5	0.24	0.92	0.52	0.77
	26.5	0.30	0.87	0.45	0.77
	27.5	0.46	0.79	0.44	0.80
	28.5	0.60	0.65	0.38	0.82
	29.5	0.82	0.39	0.33	0.86

PPV: positive predictive value; NPV: negative predictive value; SLUMS: Saint Louis University Mental Status examination; MMSE: Mini-Mental State Examination.

TABLE 5. Cutoff Scores for Dementia in Patients With Less Than High School Education

Test/Category	Cutoff Score (≤)	Sensitivity	Specificity	PPV	NPV
SLUMS/dementia	15.0	0.74	1.00	1.00	0.95
	16.5	0.85	1.00	1.00	0.97
	17.5	0.89	0.98	0.92	0.98
	18.5	0.93	0.98	0.93	0.98
	19.5	1.00	0.98	0.93	1.00
	20.5	1.00	0.96	0.82	1.00
	21.5	1.00	0.91	0.69	1.00
	22.5	1.00	0.86	0.59	1.00
	23.5	1.00	0.81	0.51	1.00
MMSE/dementia	21.5	0.37	1.00	1.00	0.89
	22.5	0.41	1.00	1.00	0.90
	23.5	0.56	0.99	0.94	0.92
	24.5	0.63	0.96	0.74	0.93
	25.5	0.78	0.92	0.66	0.95
	26.5	0.81	0.87	0.55	0.96
	27.5	0.85	0.79	0.44	0.96
	28.5	0.89	0.65	0.33	0.97
	29.5	1.00	0.39	0.25	1.00

PPV: positive predictive value; NPV: negative predictive value; SLUMS: Saint Louis University Mental Status examination; MMSE: Mini-Mental State Examination.

education, the AUC for the SLUMS and MNCD was 0.927 ($p < 0.001$) with a corresponding 95% confidence interval (CI) of 0.891–0.963 based on 137 normal cases and 50 MNCD cases. The AUC for the MMSE and MNCD was 0.671 ($p < 0.001$; 95% CI: 0.582–0.759). As shown in Figure 3, for patients with less than high school education, the AUC for the

TABLE 6. Cutoff Scores for Mild Neurocognitive Disorder (MNCD) in Patients With High School Education or More

Test/Category	Cutoff Score (≤)	Sensitivity	Specificity	PPV	NPV
SLUMS/MNCD	21.5	0.38	1.00	1.00	0.75
	22.5	0.55	0.99	1.00	0.79
	23.5	0.68	0.95	0.96	0.84
	24.5	0.85	0.87	0.85	0.87
	25.5	0.95	0.76	0.74	0.93
	26.5	0.98	0.61	0.63	0.99
	27.5	0.99	0.42	0.52	0.99
	28.5	1.00	0.22	0.42	0.99
	29.5	1.00	0.12	0.35	1.00
MMSE/MNCD	23.5	0.03	1.00	1.00	0.71
	24.5	0.05	0.99	0.64	0.71
	25.5	0.08	0.98	0.65	0.71
	26.5	0.14	0.93	0.47	0.72
	27.5	0.27	0.86	0.45	0.73
	28.5	0.45	0.76	0.43	0.76
	29.5	0.75	0.48	0.38	0.82

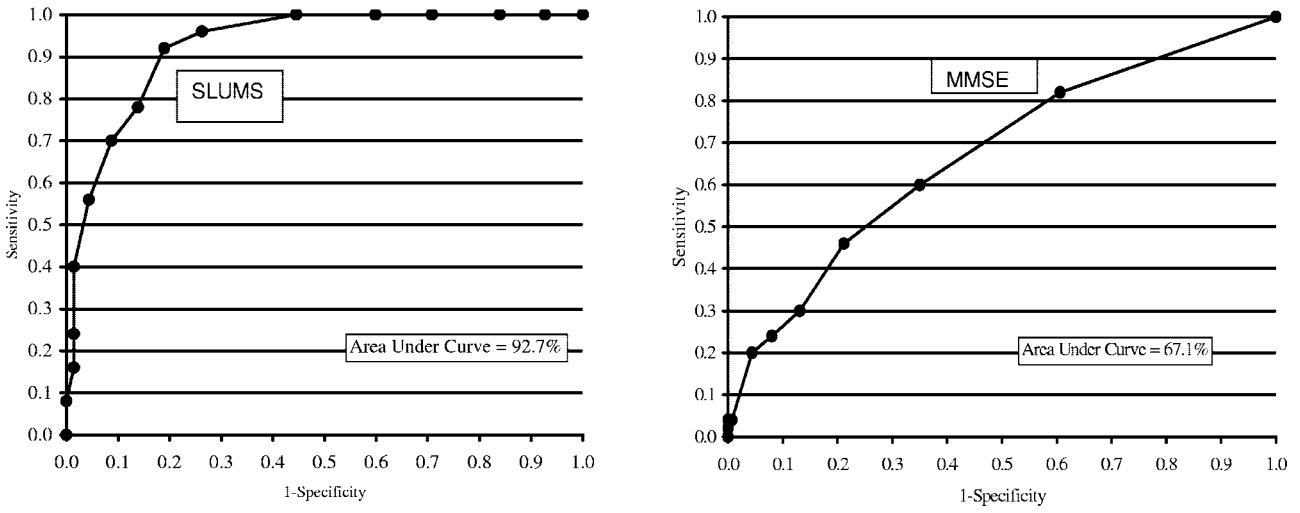
PPV: positive predictive value; NPV: negative predictive value; SLUMS: Saint Louis University Mental Status examination; MMSE: Mini-Mental State Examination.

TABLE 7. Cutoff Scores for Dementia in Patients With High School Education or More

Test/Category	Cutoff Score (≤)	Sensitivity	Specificity	PPV	NPV
SLUMS/dementia	17.5	0.58	1.00	1.00	0.93
	18.5	0.78	1.00	1.00	0.96
	19.5	0.93	1.00	1.00	0.99
	20.5	0.96	1.00	1.00	0.99
	21.5	0.98	1.00	1.00	1.00
	22.5	0.98	0.99	0.95	1.00
	23.5	0.98	0.95	0.77	1.00
	24.5	0.98	0.87	0.58	1.00
	25.5	0.98	0.76	0.42	1.00
MMSE/dementia	21.5	0.27	1.00	1.00	0.88
	22.5	0.38	1.00	1.00	0.90
	23.5	0.45	1.00	1.00	0.91
	24.5	0.53	0.99	0.88	0.92
	25.5	0.67	0.98	0.86	0.94
	26.5	0.76	0.93	0.68	0.96
	27.5	0.89	0.86	0.53	0.98
	28.5	0.94	0.75	0.40	0.99
	29.5	0.96	0.48	0.25	0.99

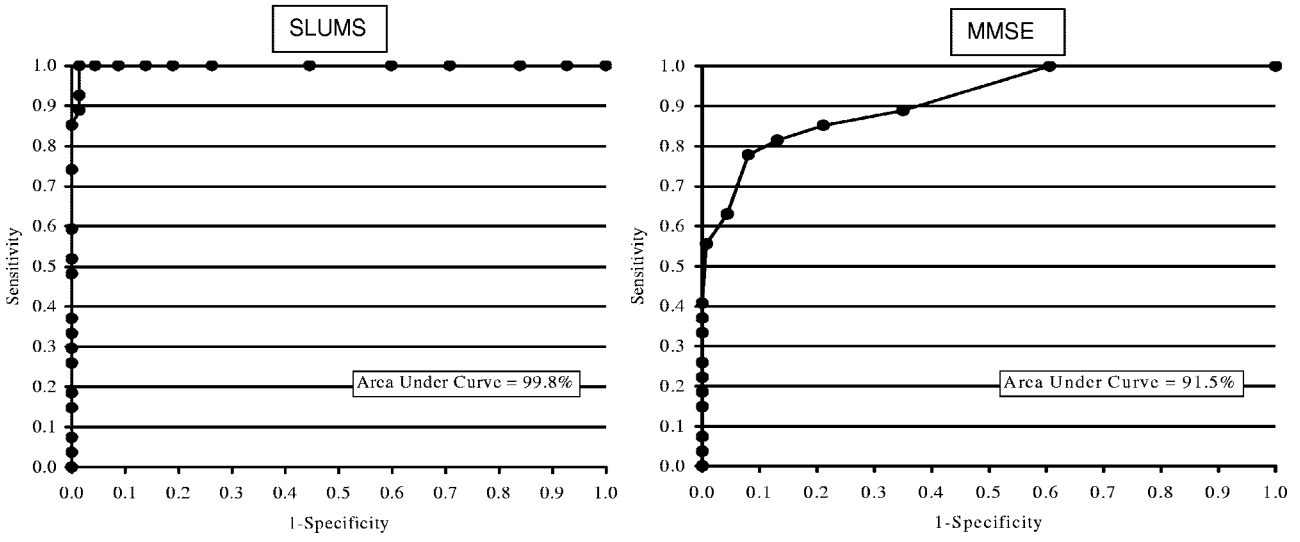
PPV: positive predictive value; NPV: negative predictive value; SLUMS: Saint Louis University Mental Status examination; MMSE: Mini-Mental State Examination.

FIGURE 2. Receiver Operator Curve for the Saint Louis University Mental Status Examination and the Mini-Mental State Examination for Mild Neurocognitive Disorder in Patients With Less Than High School Education



SLUMS: Saint Louis University Mental Status Examination; MMSE: Mini-Mental State Examination.

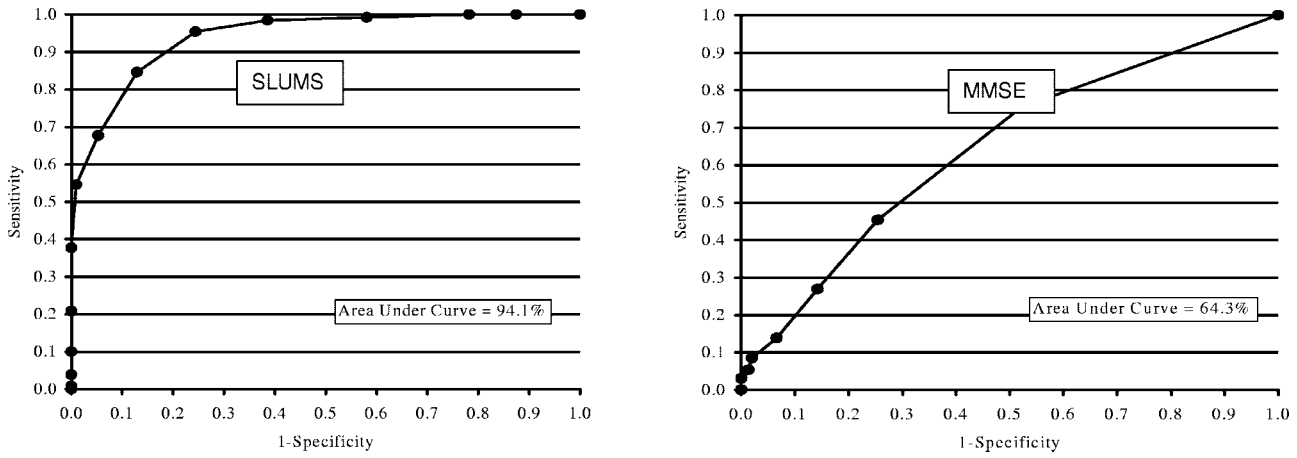
FIGURE 3. Receiver Operator Curve for the Saint Louis University Mental Status Examination and the Mini-Mental State Examination for Dementia in Patients With Less Than High School Education



SLUMS: Saint Louis University Mental Status Examination; MMSE: Mini-Mental State Examination.

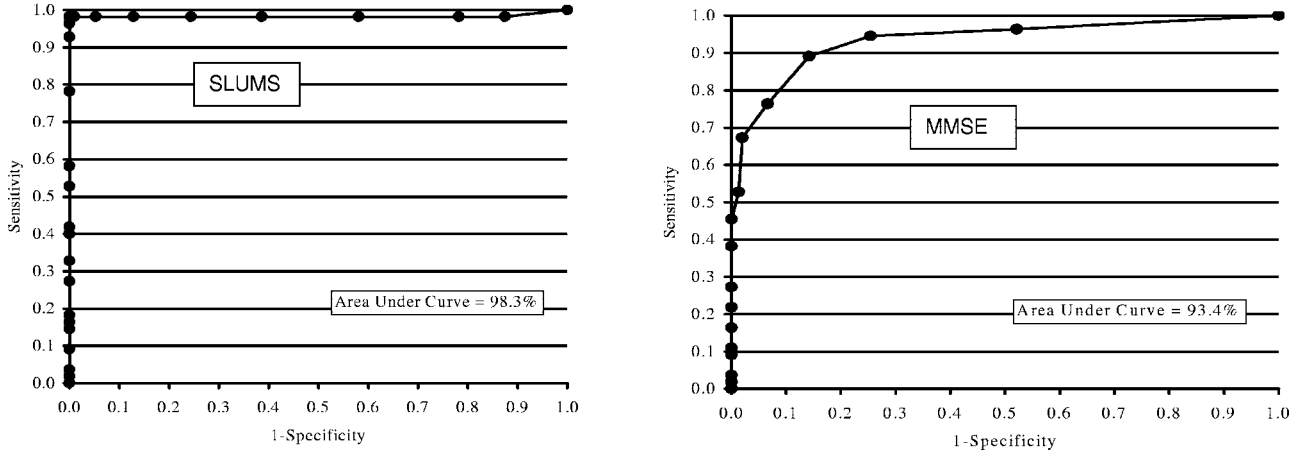
SLUMS and dementia was 0.998 ($p < 0.001$; 95% CI: 0.995–1.00) based on 137 normal cases and 27 dementia cases. The AUC for the MMSE and dementia was 0.915 ($p < 0.001$; 95% CI: 0.853–0.976). Figures 4 and 5 contrast the curves for patients with MNCD and those with dementia with a high school education or more. As shown in Figure 4, for patients with a high school education or more, the AUC for the SLUMS and MNCD was 0.941 ($p < 0.001$; 95% CI: 0.919–0.963) based on 303 normal cases and 130 MNCD

FIGURE 4. Receiver Operator Curve for the Saint Louis University Mental Status Examination and the Mini-Mental State Examination for Mild Cognitive Disorder in Patients With High School Education or More



SLUMS: Saint Louis University Mental Status Examination; MMSE: Mini-Mental State Examination.

FIGURE 5. Receiver Operator Curve for the Saint Louis University Mental Status Examination and the Mini-Mental State Examination for Dementia in Patients With High School Education



SLUMS: Saint Louis University Mental Status Examination; MMSE: Mini-Mental State Examination.

cases. The AUC for the MMSE and MNCD was 0.643 ($p < 0.001$; 95% CI: 0.587–0.700). As shown in Figure 5, for patients with a high school education of more, the AUC for the SLUMS and dementia was 0.983 ($p < 0.001$; 95% CI: 0.950–1.00) based on 303 normal cases and 55 dementia cases. The AUC for the MMSE and dementia was 0.934 ($p < 0.001$; 95% CI: 0.892–0.977).

ROCs were calculated from sensitivity and 1-specificity values for the range of scores obtained on each item of the SLUMS as a function of diagnosis and education. AUC was estimated for each item using the nonparametric approach. Table 8 summarizes the results. For patients with less than a high school education (137 normal, 50 MNCD, 27 dementia), SLUMS items corresponding to animal naming, de-

TABLE 8. SLUMS Item Discrimination as a Function of Education and Cognitive Status (*DSM–IV*)

	Less Than High School				High School or More			
	MNCD		Dementia		MNCD		Dementia	
SLUMS Items	Area Under Curve (95% CI)[a]	p	Area Under Curve (95% CI)	p	Area Under Curve (95% CI)	p	Area Under Curve (95% CI)	p
Day of the week	0.51 (0.42–0.61)	0.83	0.65 (0.52–0.78)	<0.05	0.51 (0.45–0.57)	0.74	0.61 (0.52–0.70)	<0.05
Year	0.52 (0.42–0.62)	0.68	0.59 (0.46–0.72)	0.13	0.51 (0.45–0.57)	0.84	0.57 (0.48–0.66)	0.09
State	0.50 (0.41–0.59)	1.00	0.56 (0.43–0.68)	0.36	0.50 (0.44–0.56)	1.00	0.54 (0.46–0.63)	0.28
Calculation story problem								
Money spent	0.52 (0.42–0.61)	0.69	0.67 (0.55–0.80)	<0.01	0.53 (0.47–0.59)	0.36	0.62 (0.52–0.71)	<0.01
Money left	0.57 (0.47–0.66)	0.16	0.78 (0.67–0.89)	<0.001	0.57 (0.51–0.63)	<0.05	0.71 (0.62–0.79)	<0.001
Animal naming	0.62 (0.53–0.71)	<0.01	0.85 (0.77–0.94)	<0.001	0.66 (0.60–0.72)	<0.001	0.84 (0.77–0.91)	<0.001
Delayed recall—five objects	0.74 (0.66–0.82)	<0.001	0.91 (0.86–0.96)	<0.001	0.75 (0.70–0.80)	<0.001	0.92 (0.87–0.96)	<0.001
Digit span	0.65 (0.56–0.74)	<0.01	0.72 (0.61–0.84)	<0.001	0.63 (0.57–0.69)	<0.001	0.80 (0.73–0.87)	<0.001
Clock drawing—numbers								
Numbers	0.54 (0.45–0.64)	0.35	0.81 (0.72–0.91)	<0.001	0.56 (0.50–0.62)	<0.05	0.70 (0.62–0.78)	<0.001
Time	0.61 (0.52–0.71)	<0.05	0.85 (0.76–0.94)	<0.001	0.59 (0.53–0.65)	<0.01	0.82 (0.75–0.89)	<0.001
Identification—triangle	0.53 (0.44–0.63)	0.49	0.55 (0.42–0.67)	0.43	0.51 (0.45–0.57)	0.77	0.55 (0.46–0.64)	0.26
Differentiation—figure size	0.50 (0.41–0.59)	0.98	0.56 (0.44–0.69)	0.30	0.50 (0.44–0.56)	0.93	0.52 (0.44–0.61)	0.63
Immediate paragraph recall								
Who (name)	0.61 (0.52–0.71)	<0.05	0.78 (0.66–0.89)	<0.001	0.57 (0.51–0.63)	<0.05	0.68 (0.59–0.77)	<0.001
What (work/job)	0.62 (0.52–0.72)	<0.05	0.84 (0.75–0.93)	<0.001	0.58 (0.52–0.64)	<0.01	0.72 (0.64–0.81)	<0.001
When (returned to work)	0.72 (0.63–0.81)	<0.001	0.81 (0.71–0.91)	<0.001	0.61 (0.55–0.67)	<0.001	0.78 (0.70–0.86)	<0.001
Where (state lived in)	0.68 (0.58–0.77)	<0.001	0.83 (0.73–0.92)	<0.001	0.69 (0.63–0.75)	<0.001	0.76 (0.68–0.84)	<0.001

[a]Based on receiver operator curve (ROC) plots of sensitivity and 1-specificity. Area under the curve (AUC) and 95% confidence interval (CI) were estimated using the nonparametric approach.

DSM-IV: Diagnostic and Statistical Manual of Mental Disorders-IV; SLUMS: Saint Louis University Mental Status Examination; MNCD: mild neurocognitive disorder; CI: confidence interval.

layed recall, digit span, correct time on the clock drawing, and the four items representing immediate paragraph recall significantly discriminated normal patients from patients with MNCD. Also for this group, items corresponding to orientation to day of the week, calculation, animal naming, delayed recall, digit span, clock drawing, and immediate paragraph recall significantly discriminated normal patients from patients with dementia. For the group with a high school education or more (303 normal, 130 MNCD, 55 dementia), SLUMS items corresponding to the subtraction portion of the calculation problem, animal naming, delayed recall, digit span, clock drawing and time, and the immediate paragraph recall significantly discriminated normal patients from patients with MNCD. Also in this group, SLUMS items corresponding to orientation to day of the week, calculation, animal naming, delayed recall, digit span, clock drawing, and immediate paragraph recall significantly discriminated normal patients from patients with dementia. Orientation to year and state of residence, figure identification, and differentiation of figure size did not discriminate normal patients from either MNCD or dementia in both education groups. Across both groups and diagnoses, animal naming, delayed recall, digit span, and immediate paragraph recall were the strongest and most consistent discriminators.

DISCUSSION

The present analysis showed that the sensitivity and specificity appear similar for both SLUMS and MMSE in detecting dementia, but the SLUMS appeared to be possibly better than the MMSE for differentiating MNCD from normal cognitive functioning From these data, we suggest different cutoff scores for the SLUMS examination than initially published before validation.[33] The scores for mild neurocognitive disorder and dementia for patients with less than high school education are 23.5 and 19.5, respectively. These cutoffs yield sensitivity/

specificity values of 0.92/0.81 and 1.0 /0.98, respectively. The cutoff scores for mild neurocognitive disorder and dementia for patients with high school education or higher are 25.5 and 21.5, respectively. Sensitivity/specificity values for these cutoffs are 0.95/0.76 and 0.98/1.0, respectively. On the item discrimination analysis, four items did not significantly affect the outcomes for the SLUMS, namely orientation, year and state of residence, figure identification, and differentiation of figure size. The present results suggest that these items do not contribute to the sensitivity/specificity of the SLUMS.

Both SLUMS and MMSE can be used by clinicians to identify dementia, but SLUMS has the advantage that it can help the clinician identify patients with MNCD on the initial visit compared with MMSE, which requires a follow-up screening and following a decline in scores.[34] This early detection of MNCD offers the opportunity for the clinicians to begin early treatment for MNCD as they become available. Also, MMSE has the limitation of a ceiling effect in patients with higher education.[35]

A limitation of this study is that the data were obtained from primarily white, male patients at a VA medical center. The extent to which the results reported here generalize to other patient populations is an open question for future research. An important limitation is the current controversies over the definition of MNCD. The study methodology is another limitation as the same clinicians who administered the SLUMS and MMSE made the classifications of normal cognitive functioning, MNCD, or dementia. The lack of independence of the two activities introduces a potential investigator expectation confound into the data. Finally, the number of patients with dementia and the number of patients with MNCD with less than a high school education were relatively low, prompting the need for further research on the SLUMS in larger samples and different ethnic backgrounds.

This study indicates that the SLUMS and MMSE both can be used as a screening tool to detect dementia. SLUMS also recognizes a group of patients with mild neurocognitive disorder, which the MMSE failed to recognize as defined by *DSM–IV* criteria. This needs to be further investigated. Neither the SLUMS nor the MMSE can substitute for clinical assessment and neuropsychologic testing in the diagnosis of MNCD or dementia. The authors further acknowledge that there is no single agreed-on definition of MNCD, and data from this study should be used with caution when diagnosing mild neurocognitive disorder that needs further investigation.

Presented at the 56th Annual Scientific meeting of Gerontological Society of America, San Diego, 2003; and the annual meeting of the American Geriatric Society, Las Vegas, May 2004.

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