Validation of a Cognitive Test for Delirium in Medical ICU Patients

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Patients with delirium, dementia, depression, and schizophrenia were administered a newly developed test designed to identify delirium in an intensive care unit (ICU) setting. Two alternate forms of the Cognitive Test for Delirium (CTD) were highly correlated. The delirium patients performed least well, and an optimal cutoff score derived from relative-operating characteristic analysis resulted in a sensitivity of 100% and a specificity of 95%. In a follow-up study, the Mini-Mental State Exam could not be administered to 42% of the ICU patients who completed the CTD. Early identification of delirium with the CTD may lead to timely treatment of specific etiologic conditions and a reduction in mortality and morbidity. (Psychosomatics 1996; 37:533–546)

Delirium or acute confusional state is characterized by attentional impairment, disorganized thinking, disorientation, memory impairment, reduced level of consciousness, as well as disturbances in perception, sleep-wake cycle, and psychomotor activity. The development of delirium is associated with increased mortality, longer hospitalization, and higher rates of institutionalization,[1-5] although illness severity and underlying dementia may explain the higher mortality.[2,3] Persistent symptoms may be common,[3,6] reflecting continuing brain dysfunction and/or preexisting undiagnosed dementia. Despite its clinical importance, relatively little research on delirium has been done, especially in critical care settings. Research has been hampered by a number of difficulties, including the lack of measurement instruments that are both valid and practical for the critically ill.

Prevalence of delirium among patients admitted to the hospital and the incidence of delirium during the course of hospitalization or after surgical procedures are difficult to determine given patient selection biases, variable diagnostic criteria, and frequent reliance on retrospective rather than prospective investigations. Prevalence rates of 10% to 13% have been found in general medical patients,[5,7,8] but delirium is more common among elderly persons and the critically ill. Numerous studies of elderly hospitalized patients have found prevalence rates that exceed 15%.[9,10] Some studies suggest that approximately 30% of elderly patients not presenting with confusion at time of admission to general medical and surgical wards may later develop confusion (symptom) or delirium (diagnosis).[11,12] Prospective studies comparing different age groups have found a higher incidence of confusion in a general medical ward

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and a higher incidence of postsurgical cognitive impairment among the elderly.[11,13] Few data pertaining to the critically ill exist, except concerning cardiac surgery, after which delirium is very common.[14] While its incidence has declined over the past 20 years,[15] from 25% to 35% of cardiac surgery patients experience postoperative cognitive deficits and/or delirium.[16] In a prospective pilot study of consecutive medical patients in an intensive care unit (ICU), we found a 48% incidence of delirium and a 26% incidence of significant agitation.[17]

Medical ICU patients are a heterogeneous group with a disproportionate number of risk factors for delirium, including advanced age and multiple acute and chronic medical problems (e.g., pneumonia, sepsis, hepatic failure, shock). Acute confusion and agitated delirium can significantly interfere with effective patient care in the ICU, where most patients have multiple invasive elements of treatment, including indwelling vascular catheters, pacing wires, monitoring devices, urinary catheters, feeding tubes, postoperative drains, and/or endotracheal tubes. Our prospective study of 136 medical ICU patients across 759 nursing shifts[18] indicated a 9% incidence of overt agitation by shift, including 36 tube/catheter removals and 27 assaults on a caregiver. The patients with agitated delirium required significantly more nursing intervention and frequent use of sedative drugs and restraints (40% and 30% of the shifts, respectively). Although comparable descriptive data were not collected for the patients with delirium characterized by apathy and somnolence, some compromise of care dependent on patient effort (e.g., weaning from a mechanical ventilator) seems likely.

Given the negative effects of delirium on the care of the medical ICU patient, early recognition is important. However, delirium is often undetected by physicians and nurses, or misdiagnosed.[2,4,19–21] The present study assesses the validity of a newly developed cognitive test designed for identifying patients with delirium in an ICU setting. Although a number of other delirium assessment instruments have been developed,[22,23] they vary considerably in reliability, validity, generalizability, and utility. Most (e.g., Delirium Symptom Interview, Delirium Rating Scale, Confusion Assessment Method) include cognitive dysfunction as only one of a larger number of domains. In her review article, Trzepacz[22] concluded that most currently available instruments for assessing delirium can be enhanced by the use of standardized cognitive tests. Our test was designed to focus solely on cognitive function; to be brief and easily administered; and to accommodate ICU patients who may be intubated, motorically restricted, or functionally illiterate. This study specifically addresses the test's internal consistency and alternate form reliability, its ability to discriminate delirium from dementia and acute psychiatric illness, and its concurrent relationship to independent measures of cognitive status and symptom severity.

METHODS

Subjects

Subjects with delirium ($N = 22$) were recruited from the medical ICUs at the Medical College of Virginia Hospitals and referrals to the Division of Consultation-Liaison Psychiatry. The study was conducted in 1990–1994. The diagnosis of delirium was based on DSM-III-R criteria and was made by a senior consultation-liaison psychiatrist (second author) after clinical interview, mental status exam, and review of medical chart. The patients with schizophrenia ($N = 25$) and depressive illness ($N = 30$) were recruited from the Medical College of Virginia's inpatient psychiatry service. The attending psychiatrist and multidisciplinary inpatient teams rendered the diagnoses. Two investigators (first and second authors) retrospectively reviewed discharge summaries (without knowledge of test results) to confirm diagnoses and exclude the patients with a history of substance abuse, major medical illness, or neurologic disorders that may affect cognitive function. All subjects met DSM-III-R criteria for schizophrenia, major depression, or dysthymia. The dementia patients ($n = 26$) were

clinical referrals with a range of disorders (Table 1). Only outpatients with dementia were included to minimize the confounding effects of acute or poorly controlled medical problems. The score (mean ± SD) of the dementia patients on the Mattis Dementia Rating Scale (Mattis DRS)[24] was 114.8 ± 16.8 SD.

Consistent with DSM-III-R[25] criteria and the cognitive symptoms common to many neuropathogenic formulations of delirium,[26] the test was designed to assess orientation, attention span, memory, comprehension/conceptual reasoning, and vigilance. The Cognitive Test for Delirium (CTD) is shown in Appendix 1. Scores for each of these five areas of functioning range from 0 to 6 and are summed for a maximum total score of 30. Alternate form items are available for the memory, comprehension/conceptual reasoning, and vigilance sections. Visual stimuli are enlarged (e.g., approximate height of 1.5 cm for print and 3.5 cm for pictures) and presented in a manner to maximize the attention of the subject (simultaneously reading aloud, naming and/or pointing). Pictorial stimuli are used in memory testing, because a redundant image and verbal code facilitates retention and could minimize floor effects in a sample of delirium patients. The subject's responses to all test items are nonverbal (pointing, nodding head, raising hand). Test administration time is approximately 10 to 15 minutes for each patient.

TABLE 1. Diagnoses of dementia patients

Disorder	*n*
Alzheimer's disease	9
Multi-infarct or mixed Alzheimer's–multi-infarct[a]	7
Mixed multi-infarct and alcoholic dementia	3
Alcoholic dementia	2
Severe head injury (chronic) and seizure disorder	1
Communicating hydrocephalus	1
Human immunodeficiency virus infection	3

[a]Four patients had systemic medical illness (chronic obstructive pulmonary disease or end-stage renal disease) that probably contributed to cognitive impairment.

Orientation for month, time of day, and place are assessed by using a 4-choice visual-recognition format. The examiner reads each choice aloud while pointing at it, and the subject chooses an answer by pointing. Multiple-choice items for orientation are standardized across exams (e.g., for Question 1 the first multiple-choice answer is always 4 months earlier than the current month, the second is always 2 months later than the current month, etc.). Attention span is assessed with the Visual Memory Span subtest of the Wechsler Memory Scale–Revised,[27] which requires a pointing response. Memory is assessed for five common pictured objects shown individually for 3 seconds as the examiner points to each item and names it. Incidental memory for the number of pictures that were presented is assessed by using a 4-choice visual-recognition format. The examiner reads each choice aloud while pointing at it, and the subject chooses an answer by pointing. Memory for the five pictures is assessed by using a yes/no recognition-memory paradigm (five stimuli and five distractor items). The subject responds nonverbally by nodding his/her head yes or no. The pictures are from an unpublished cognitive screening exam (Appendix 2). Comprehension is assessed by using four questions requiring a yes/no response from the Auditory Comprehension, Part D, Complex Ideational Material subtest of the Boston Diagnostic Aphasia Examination (BDAE).[28] Across the two alternate forms, six questions are identical to those from the BDAE and two (1a and 1b) are modified. Each question is read twice, and the subject responds nonverbally with head nods. Conceptual reasoning is assessed by pointing to and naming each of four common pictured objects and asking the subject to point to the one that does not belong with the other three. The pictures are from the set published by Snodgrass and Vanderwart[29] (Appendix 3). Vigilance is assessed by using an oral administration of single rows from a letter-cancellation task,[30] in which the target is an individual letter (H) or one of two letters (C and E). Each row

has 52 characters and 18 targets. After a short practice sequence, each letter is read at the rate of 1 per 2 seconds, and the subject is asked to respond to target stimuli by raising his/her hand from the table.

Procedure

All patients were administered the CTD and Mini-Mental State Exam (MMSE) by a bachelor's-level psychologist technician. Although an effort was made to recruit testable subjects, two ICU delirium patients were unable to complete the MMSE. The form of the CTD administered was randomized across subjects. The patients with delirium, schizophrenia, and depression were rated by nurses on a symptom scale for delirium,[31] modified for use in an ICU setting. The original instrument, the Delirium Rating Scale, was shortened and simplified to facilitate its use by ICU nurses. Four items were deleted (temporal onset of symptoms, physical disorder, perceptual disturbances, and delusions), and the psychomotor behavior item was divided into two items. The modified scale has seven items (hallucinations, agitation, withdrawal, cognitive deficits, sleep-wake cycle, lability of mood, and variability of symptoms). Each item is rated up to 2, 3, or 4 points, with a total possible score of 20 points. Nurse ratings and cognitive testing were completed in the same 8- or 12-hour shift for all patients. To assess the equivalence of the two forms of the CTD, the dementia patients were given each form with intervening administration of the MMSE and Mattis DRS. The dementia group was judged to be the most appropriate for this analysis given the greater likelihood of ceiling effects in some of the depressed and schizophrenic patients. The order of administration of forms A and B was counterbalanced across the subjects with dementia.

Following the completion of the present study, we attempted to test all patients available on a given day at each of four ICUs, and we recorded the number who were unable to complete the CTD or MMSE for a particular reason (e.g., agitation, intubation). The patients undergoing medical procedures or who should not be disturbed, as judged by nursing staff, were excluded. Test procedures were completed after describing the study's aims and methods, although written informed consent was waived for inpatients by our Institutional Review Board. Consent was waived, because the protocol posed no risks, and because some form of mental status testing is a standard part of care in the ICU and psychiatric unit.

Data Analysis

Statistical analyses were done with JMP software.[32] The reliability of the CTD was assessed by calculating coefficient alpha using the five subtest scores (i.e., internal consistency) and by calculating an intraclass correlation coefficient for the scores of the dementia patients across the two forms of the test (i.e., alternate form reliability). The latter correlation coefficient was considered to be a conservative measure of reliability that reflects both time-to-time and form-to-form variability. A principal component analysis was done to assess whether the five subtest scores were unidimensional.

Criterion or empirical validity was assessed by contrasting the performance of the patients with delirium to that of the patients with dementia, schizophrenia, and depressive illness. Multivariate analysis of variance (MANOVA) of CTD and MMSE scores and analysis of covariance (ANCOVA) of the nurse rating scale scores, taking into account group demographic differences, and appropriate post hoc tests (ANCOVAs, Tukey's honest significant difference [HSD]) were used to examine the ability of each test to differentiate the diagnostic groups. Optimal cutoff scores for each test were estimated by using relative operating characteristic (ROC) analysis and used to compare their relative sensitivity and specificity in classifying the delirium patients. Given our hypothesis that delirium patients would score lowest on the CTD, a planned contrast was used to simultaneously compare the delirium patients with the three other diagnostic groups. Construct validity was assessed by calculating Pearson correlation

coefficients between the CTD and the MMSE and the nurse rating scale.

RESULTS

The four groups did not differ on demographic variables, with the exception of those that might be expected on the basis of known prevalence rates. There was a higher proportion of women in the depression group ($\chi^2 = 10.1$, df = 3, $P < 0.02$ overall and Fisher's exact, $P < 0.01$, comparing depression with other groups), and the mean ages for the delirium and dementia groups were higher than those for the other two groups ($F_{[3,99]} = 39.5$, $P < 0.0001$ overall and $t = 10.3$, df = 101, $P < 0.0001$, comparing the delirium and dementia patients grouped together with the depression and schizophrenia patients grouped together). There was also a nonsignificant trend for a group difference in education ($\chi^2 = 6.9$, df = 3, $P < 0.10$) attributable to the higher proportion of delirium subjects without a high school education (Fisher's exact, $P < 0.01$). See Table 2.

The reliability (coefficient alpha) of the total CTD score formed by summing the five subtest scores was 0.87. The first factor in a principal components analysis accounted for 73% of the variability, indicating that the CTD is measuring a unidimensional construct. The dementia patients were given each form of the test, with order of administration counterbalanced across the subjects. ANOVA indicated no carryover effects from one administration of the CTD to the next ($P > 0.5$). A 2 x 2 (Order × Form) ANOVA indicated no difference in CTD scores dependent upon the order of administration ($P > 0.7$) or test form ($P > 0.6$). The two forms were highly correlated, as shown by a high estimate of the intraclass correlation ($r_{ICC} = 0.90$) for the dementia patient data.

MANCOVA of CTD and MMSE scores that took into account gender, age, and education differences revealed a significant group effect (Wilk's λ: $F_{[6,180]} = 32.4$, $P < 0.0001$). ANCOVA found the groups differed on the CTD ($F_{[3,99]} = 146.0$, $P < 0.0001$) and MMSE ($F_{[3,97]} = 102.6$, $P < 0.0001$). Post hoc tests (Tukey's

TABLE 2. Patient demographic data

Measure	Subjects			
	Delirium ($n = 22$)	Dementia ($n = 26$)	Depression ($n = 30$)	Schizophrenia ($n = 25$)
Age, mean ± SD	62.5[a] ± 14.4	64.9[a] ± 12.3	38.8 ± 14.6	34.4 ± 14.6
Range	21–92	38–78	21–83	22–69
Gender, %				
Female	45.5	53.8	80.0[b]	44.0
Male	54.5	46.2	20.0	56.0
Race, %				
African American	50.0	34.6	50.0	40.0
Caucasian	50.0	65.4	50.0	60.0
Education, %				
Unknown	18.2			
Less than 9th	22.7[c]	15.4	10.0	4.0
Some high school	40.9	15.4	30.0	36.0
High school/GED	4.5	23.1	23.3	28.0
Some college	4.5	34.6	26.7	20.0
College graduate		7.7	10.0	8.0
Postgraduate	9.1	3.8		4.0

[a] $P < 0.0001$ compared with depression and schizophrenia patients, *t*-test.
[b] $P < 0.01$ compared with delirium, dementia, and schizophrenia patients, Fisher's exact.
[c] $P < 0.01$ compared with dementia, depression, and schizophrenia, Fisher's exact.

HSD) indicated that for each measure the delirium group performed worse than the other three groups, and the dementia group performed worse than the depression and schizophrenia groups. The delirium, depression, and schizophrenia groups also differed on the nurse rating scale ($F_{[2,74]} = 18.6$, $P < 0.0001$). Post hoc tests (Tukey's HSD) indicated that delirium patients scored significantly higher (i.e., more symptoms) than the depression and schizophrenia patients, who did not differ from one another. Because the variability of scores on the CTD, MMSE, and nurse rating scale was not equal across groups (Table 3), analyses were repeated by using the Welch ANOVA, which allows standard deviations to be different, and the Wilcoxon rank-sum test, a nonparametric statistic. Both sets of analyses confirmed the same group differences for the CTD, MMSE, and nurse rating scale (P-values: < 0.0001).

Although there was substantial overlap in the ages of the four groups and the ANCOVA (which took into account age differences) was statistically significant for the CTD, the effects of age were explored further given the differences between the delirium patients and those with depression and schizophrenia. The relationship between age and CTD scores was not consistent across the three groups (Table 3). Visual inspection of scatterplots revealed that CTD scores were higher for depressed and schizophrenic patients than for delirium patients across all ages. When a subset of 13 older depressed and schizophrenic patients (mean age = 56.5) was contrasted with the delirium group on the CTD, the difference was statistically significant ($F_{2,30} = 64.9$, $P < 0001$).

An ROC analysis indicated that for both the CTD and MMSE an optimal cutoff score to discriminate delirium from other disorders was ≤ 18 (or < 19). Sensitivity was 100% for both tests. Specificity was 95.1% for the CTD and 93.8% for the MMSE. No patient with delirium, schizophrenia, or depression was misclassified, but some dementia patients were incorrectly identified with the delirium group. In contrast, the nurse rating scale (optimal cutoff score of > 3) had a sensitivity of 86.4% and specificity of 63.6% for the groups of patients with delirium, depression, or schizophrenia. Three delirium patients were incorrectly identified with the psychiatric groups, and 13 schizophrenic and 7 depressed patients were misclassified in the delirium group. The CTD correlated highly with the MMSE in the delirium and dementia groups and moderately in the depression and schizophrenia groups (Table 4). Figure 1 graphs the CTD and MMSE scores of the patients in each of the four groups and the optimal cutoff scores derived from ROC analyses. The CTD and Mattis DRS were correlated highly in the dementia group. The CTD did not correlate

TABLE 3. Test results

Measure	Subjects			
	Delirium ($n = 22$)	Dementia ($n = 26$)	Depression ($n = 30$)	Schizophrenia ($n = 25$)
CTD, mean ± SD	9.5 ± 5.0[a]	24.5 ± 1.9[b]	28.8 ± 1.9	27.9 ± 2.2
r with age	− 0.47[c]	− 0.48[c]	− 0.44[c]	− 0.09
MMSE, mean ± SD	9.8 ± 4.8[a]	22.8 ± 4.7[b]	26.1 ± 2.4	26.6 ± 2.2
Nurse rating scale, mean ± SD	7.8 ± 3.9[b]		2.0 ± 2.3	4.4 ± 3.9

Note: CTD = Cognitive Test for Delirium; MMSE = Mini-Mental State Exam.
[a] $P < 0.05$ compared with dementia, depression, and schizophrenia patients, Tukey's studentized range (honest statistical difference) test.
[b] $P < 0.05$ compared with depression and schizophrenia patients, Tukey's studentized range (honest statistical difference) test.
[c] $P < 0.05$.

with the nurse rating scale in any group.

In the follow-up study, we attempted to test a total of 43 patients in 4 ICUs (cardiac surgery, 15; trauma surgery, 11; medical respiratory, 11; and coronary, 6). Ten patients were unable to complete the CTD or the MMSE, because of impaired level of consciousness ($n = 2$), agitation ($n = 3$), inability or unwillingness to respond meaningfully ($n = 3$), mental retardation ($n = 1$), and limited English affecting speech and comprehension ($n = 1$). Of the 33 patients who could take the CTD, 14 were unable to finish the MMSE, because of invasive elements of treatment that limited verbal responsiveness ($n = 10$) and/or motor control ($n = 3$), or because of speech/language deficiencies ($n = 2$). No patient was able to complete the MMSE but not the CTD.

DISCUSSION

The CTD is a reliable measure of cognitive function able to differentiate patients with delirium from those with dementia and other major psychiatric disorders. It can be used with a cutoff score, or as a continuous, unidimensional measure of cognition in delirium. The practical utility of the CTD for very ill patients is demonstrated by its ability to accommodate ICU patients who are intubated or motorically restricted, although limited cooperation (e.g., extreme agitation) or abilities (e.g., poor comprehension) may preclude its use. Repeated testing or systematic observation is important in an ICU setting, where delirium may develop abruptly and clinical diagnosis may be confirmed by fluctuating intensity of symptoms. The lack of a practice effect over a short time interval, the availability of equivalent forms, and the absence of serial-order effects on test scores are advantages of the CTD in the clinical assessment of delirious patients.

The intraclass correlation coefficient for alternate forms of the CTD is comparable to the 24-hour test-retest reliability coefficients for the MMSE in the original study of Folstein and colleagues.[33] The high intraclass correlation coefficient is encouraging, because it reflects low variability attributable to practice, difficulty level of forms, and serial position of test-form administration. A cutoff score was derived that minimizes the possibility of missing a case of delirium without resulting in a high false-positive rate. No patient with mild-to-moderate dementia scored below the cutoff or lower than any patient with delirium. The four dementia subjects incorrectly classified as part of the delirium group were severely impaired (mean Mattis DRS score = 91). All of these subjects and 1 additional dementia patient with severe impairment (Mattis DRS score = 92) were incorrectly classified by the MMSE as part of the delirium group. Three dementia patients with severe impairment (mean Mattis DRS score = 95) were correctly classified by CTD.

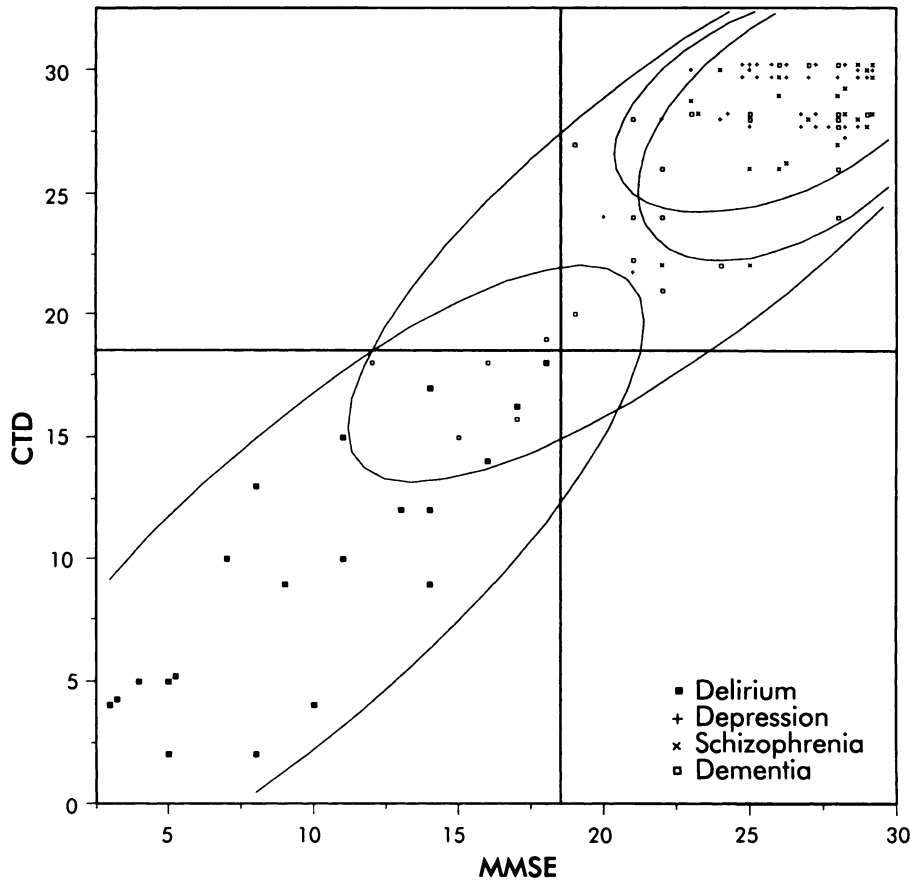
For clinical purposes, a score below the cutoff cannot reliably distinguish delirium from a severe dementia. This is partly because patients with severe dementia typically present with some confusion, and comorbidity (e.g.,

TABLE 4. Correlations between the Cognitive Test for Delirium (CTD) and other scales

	Subjects			
Measure	Delirium ($n = 22$)[a]	Dementia ($n = 26$)	Depression ($n = 30$)	Schizophrenia ($n = 25$)
MMSE	0.82[a,*]	0.81[*]	0.51[**]	0.48[***]
Nurse rating scale	−0.02		0.02	−0.13
Mattis DRS		0.76[*]		

Note: MMSE = Mini-Mental State Exam; Mattis DRS = Mattis Dementia Rating Scale.
[a] $n = 20$ for correlation between CTD and MMSE.
[*] $P < 0.0001$, [**] $P < 0.01$, [***] $P < 0.05$.

FIGURE 1. Scatterplot of Cognitive Test for Delirium (CTD) raw score vs. Mini-Mental State Exam (MMSE) raw score for the four groups of subjects. Bivariate normal density ellipses at 95% confidence show the correlation between scores and the lack of overlap between the delirium and nondelirium groups.



Note: Overlapping points have been jittered to separate the plotted values.

developing or resolving delirium) is difficult to rule out even in the presence of full historical information, current laboratory studies, and serial evaluations (which were not done in this study). Indeed, the risk for delirium is higher in patients with dementia, as reflected in the "dementia with delirium" categories in DSM-IV (sections 290.11, 290.3, and 290.41). Only three patients with delirium scored higher on the CTD than any of the dementia patients (scores of 16–18 vs. scores of 15 and 16 in 2 severely demented patients). Because the clinical diagnosis of delirium and cognitive testing often occurred hours apart, it is possible that these higher scores occurred with those patients whose delirium had started to resolve.

The high correlations between the CTD and other measures of cognitive function (MMSE, Mattis DRS) were expected. Lower correlations between the CTD and MMSE in the depression and schizophrenia groups than in the delirium and dementia groups reflected lower variability in

scores for the former groups (visual inspection of scatterplots), although differences in performance variables (e.g., attention, motivation) might be contributory. The absence of any relationship between the CTD and the nurse rating scale may seem surprising, but the latter scale used a different method and tapped a very different behavioral domain, including temporal factors unrelated to severity of impairment per se (i.e., symptom variability). This explanation is consistent with the finding that correlations between the MMSE and nurse rating scale were similarly very low.

The lower specificity and sensitivity of the nurse rating scale than the CTD in correctly classifying schizophrenic, depressed, and delirious patients suggest that a cognitive screening test like the CTD may be adequate for identifying delirium in a psychiatric setting. The presence of hallucinations, agitation, withdrawal, and labile mood in hospitalized schizophrenic and depressed patients might be expected to result in a high misclassification rate with the nurse rating scale. Given the relative independence of behavioral domains tapped by nurse ratings and cognitive testing, a combination of methods may be most appropriate for identifying delirium in other medical units and nursing homes. A combination of methods may be particularly useful in nonpsychiatric settings, where the base rate of symptoms, such as hallucinations and mood disturbance, is lower. Some symptoms of delirium need to be observed and/or reported (perceptual, psychomotor, sleep-wake cycle disturbances), as with the nurse rating scale. Observation of the latter symptoms might help distinguish delirium from severe dementia. The nurse rating scale may also be valuable for predicting which patients' care will be seriously disrupted by delirium.[18]

The present study did not evaluate the possible effect of education on CTD test scores. Relationships with education might be attenuated in patient groups with significant cognitive impairment[34] and limited by ceiling effects in subjects who are higher functioning. The patients with depression, schizophrenia, and mild dementia, for example, typically scored in the range of 28–30. The delirium patient sample was not large enough to consider specific medical comorbidity and explore the possible effects of etiology on the sensitivity of the CTD or nurse rating scale.

The CTD was designed so that it could be used in severely ill ICU patients, who constituted most of the delirium subjects in this study. Whether the CTD has comparable sensitivity and specificity in less critically ill patients, including those in other settings (medical units, nursing homes), is unknown and requires further study. Further research with the CTD can illuminate the relationship between cognitive dysfunction and behavioral manifestations in delirium, measuring the latter by using other instruments. The relative contribution of the separate elements of the CTD can be examined to see if it can be shortened without sacrificing too much sensitivity or specificity.

In the ICU or other medical settings, early identification of cognitive changes consistent with delirium would presumably lead to earlier diagnosis and treatment of specific etiological conditions, such as bacterial sepsis, metabolic derangements, and medication toxicity. The CTD could also help guide the use of nonspecific treatments like sedation and restraints, particularly as a measure in controlled trials. Improved treatment of delirium may reduce the risk of agitation and related complications, and decrease mortality, duration of hospitalization, and likelihood of persistent symptoms.

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APPENDIX 1. Cognitive Test for Delirium and conversion formulas for scoring

ORIENTATION (_____/3)

Read each answer as you point to it, and circle choice.

1. WHAT MONTH IS THIS? POINT TO THE CORRECT ANSWER.

   4 months earlier | 2 months later | correct month | 4 months later

   WHAT TIME OF DAY IS IT? POINT TO THE CORRECT ANSWER.

   3 hours later | correct time | 6 hours earlier | 9 hours later

   WHAT IS THE NAME OF THE PLACE YOU ARE IN? POINT TO THE CORRECT ANSWER.

   doctor's office | home | St. Luke's | Medical College of Virginia

ATTENTION SPAN (_____/26)

2. Forward _____/14
3. Backward _____/12

Wechsler Memory Scale–Revised, Visual Memory Span Subtest

MEMORY (_____/12)

4. I AM GOING TO SHOW YOU PICTURES OF COMMON OBJECTS. WATCH CAREFULLY AND TRY TO REMEMBER EACH PICTURE. Name each object as you point to it. Show each picture for 3 seconds. Circle form used.

Form A:	table	car	hammer	cup	key
Form B:	dog	knife	pants	boot	paint brush

   HOW MANY PICTURES DID I SHOW YOU? POINT TO THE CORRECT ANSWER. Read each answer as you point to it and circle choice.

   5 | 3 | 10 | 7

   Incidental Recall (0–1)× 2:_____/2

5. NOW I AM GOING TO SHOW YOU SOME MORE PICTURES. SOME YOU HAVE JUST SEEN BUT OTHERS WILL BE SHOWN FOR THE FIRST TIME. LET ME KNOW WHETHER OR NOT YOU SAW THE PICTURE BEFORE BY NODDING YOUR HEAD YES (demonstrate) OR NODDING YOUR HEAD NO (demonstrate). REMEMBER, JUST NOD YOUR HEAD YES (demonstrate) IF YOU SAW THE PICTURE BEFORE, OR NOD YOUR HEAD NO (demonstrate) IF YOU DID NOT SEE IT BEFORE. Circle correct answers.

   Form A

Car	(yes)	Key	(yes)
Glass	(no)	Truck	(no)
Lock	(no)	Cup	(yes)
Table	(yes)	Chair	(no)
Hammer	(yes)	Saw	(no)

   Form B

Fork	(no)	Toothbrush	(no)
Boot	(yes)	Knife	(yes)
Paintbrush	(yes)	Shoe	(no)
Cat	(no)	Dog	(yes)
Dress	(no)	Pants	(yes)

   Recognition:_____/10

COMPREHENSION (_____/6)

6. I AM GOING TO ASK YOU SOME QUESTIONS THAT CAN BE ANSWERED YES OR NO. IF YOUR ANSWER IS YES, NOD YOUR HEAD LIKE THIS (demonstrate). IF YOUR ANSWER IS NO, NOD YOUR HEAD LIKE THIS (demonstrate). Read each question twice, and circle correct answers. Circle form used.

   Form A

Will a stone float on water?	(no)
Can you use a hammer to pound nails?	(yes)
Do two pounds of flour weigh more than one?	(yes)
Will water go through a good pair of rubber boots?	(no)

APPENDIX 1. Cognitive Test for Delirium and conversion formulas for scoring *(continued)*

Form B

Will a leaf float on water?	(yes)
Is a hammer good for cutting wood?	(no)
Is one pound of flour heavier than two?	(no)
Will a good pair of rubber boots keep water out?	(yes)

Auditory Comprehension:_____/4

Questions 2–4, Forms A and B from Harold Goodglass & Edith Kaplan, Boston Diagnostic Aphasia Examination Booklet, p. 8. Copyright 1983 by Lea & Febiger. Reprinted by permission. Questions 1, Form A and B are derived from same source, but are modified in content.

7. WHICH ONE OF THESE DOES NOT BELONG TO THE SAME GROUP AS THE OTHER THREE? POINT TO THE CORRECT ANSWER. Read each answer as you point to it, and circle choice. Circle form used.

Form A

Bus	Train	Bicycle	Peach
Arm	House	Foot	Nose

Form B

Table	Couch	Desk	Goat
Dress	Corn	Shirt	Shoes

Conceptual Reasoning: _____/2

VIGILANCE (_____/72)

8. I AM GOING TO READ YOU A LONG SERIES OF LETTERS. WHENEVER YOU HEAR THE LETTER H, INDICATE IT BY RAISING YOUR HAND AT THE WRIST (demonstrate) AND THEN PUTTING IT BACK DOWN. Read the letter list at the rate of one letter per two seconds. Put a slash mark through each letter patient responds to and circle omissions (/ = response, 0 = omission). Before starting test, use sequence of (B H D) as an example to make sure patient understands the instructions. Repeat instructions if necessary. Circle form used.

Form A - H E G H F E H D H F H C B F H A D H C E H I H G D H
C E B H E G H I H C H E H F C I H E B H G F D H B E

Form B - H B H A E H B H C F A H F H G H C G D H C B A H G D
E H C H B E H D G H D A F H B I F H E B H D H E H G

Correct Responses × 2:_____ /

Commissions:_____/

Correct Responses–Commissions:_____/36

9. I AM GOING TO READ YOU A LONG SERIES OF LETTERS AGAIN. THIS TIME, WHENEVER YOU HEAR THE LETTER C *OR* E, INDICATE IT BY RAISING YOUR HAND AT THE WRIST (demonstrate) AND THEN PUTTING IT BACK DOWN. Administer as for H above, using as an example (B E I C). Circle form used. If patient makes 10 errors in the first 22 items, discontinue administration and give a score of zero.

Form A - C A H E F A C D C F E H B F C A D E H A E I E G D E
G H B C A G C I E H C I E F H I C D B C G F D E B A

Form B - E B C A F C B E H F A E F E G C H G D E H B A E G D
A C H E B A E D G C D A F C B I F E A D C B E A C G

Correct Responses ×2:_____/

Commissions:_____/

Correct Responses–Commissions:_____/36

Cancel H and Cancel C & E test stimuli are reprinted with the permission of Leonard Diller and Joseph Weinberg.

(continued)

APPENDIX 1. Cognitive Test for Delirium and conversion formulas for scoring *(continued)*

Conversion Formulas

Orientation	Total Raw Score (0–3) × 2 = Subtest Score (0–6)
Attention Span	Score Forward (0–14) + Score Backward (0–12) = Total Raw Score

Total Raw Score	Subtest Score
≥ 11	6
7–10	4
3–6	2
≤ 2	0

Memory: Incidental Recall (0–1) × 2 + Recognition Memory (0–10) = Total Raw Score

Total Raw Score	Subtest Score
11–12	6
9–10	4
7–8	2
0–6	0

Comprehension: Auditory Comprehension (0–4) + Conceptual Reasoning (0–2) = Total Raw Score. Total Raw Score (0–6) = Subtest Score (0–6)

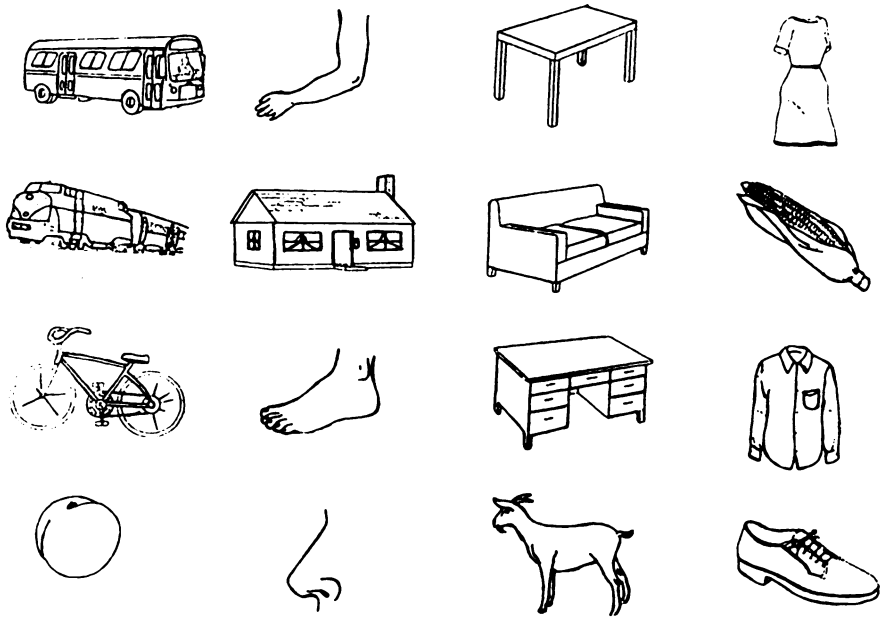
Vigilance: Cancel H Correct Responses (hits) × 2 minus Commission Errors (0–36) + Cancel C&E Correct Responses (hits) × 2 minus Commission Errors (0–36) = Total Raw Score

Total Raw Score	Subtest Score
55–72	6
37–54	4
19–36	2
0–18	0

Test Score = Sum of Five Subtest Scores (0–30)

APPENDIX 2. Pictures for the memory test: Form A stimuli and distractors in top two rows and Form B stimuli and distractors in bottom two rows

APPENDIX 3. Pictures for conceptual reasoning questions: Form A items in first two columns and Form B items in last two columns.



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