Recognition of Alzheimer's Disease: the 7 Minute Screen™

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Background and Objectives: *Because Alzheimer's disease (AD) tends to be underdiagnosed, we developed a brief neurocognitive screening battery to identify AD patients. The 7 Minute Screen™ consists of four individual tests (orientation, memory, clock drawing, verbal fluency). The screen can be rapidly administered and scored and therefore may be appropriate for use in the primary care setting. This study determined the validity and reliability of the 7 Minute Screen in distinguishing patients with AD from healthy controls.* Methods: *The 7 Minute Screen was administered to 60 consecutive referrals to a memory disorders clinic who were subsequently diagnosed with probable AD and to 60 community-dwelling individuals. Analysis of the combined scores on the four individual tests was used to determine the probability of dementia in each subject. We also evaluated test-retest and inter-rater reliability, as well as the time required to administer the battery.* Results: *When compared with the normal subjects, the patients with AD were significantly more impaired on each of the four tests included in the 7 Minute Screen. When the four tests were combined into a logistic regression model, the battery correctly diagnosed 92% of the patients with AD and 96% of the normal subjects. The battery performed equally well when only patients with mild and very mild AD were included. Mean time for administration and scoring was 7 minutes 42 seconds.* Conclusions: *The 7 Minute Screen is a reliable and valid instrument for identifying patients with AD. It appears to be a potentially useful tool for identifying patients with AD in a primary care setting.*

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Alzheimer's disease (AD) causes dementia in more than 4 million Americans[1] and is the fourth leading cause of death in the United States.[2] By some estimates, fewer than half of these patients have been diagnosed, and only a fraction of those have been treated. Additionally, research has suggested that there are up to 125 undiagnosed patients with AD in a typical primary care practice.[3] Underdiagnosis of AD, combined with the availability of new treatments, suggest a need for simple, accurate screening instruments to facilitate detection of AD.

AD tends to be underdiagnosed by primary care physicians for several reasons (Table 1). Failure to diagnose the illness can result in a missed opportunity for early treatment and for making accurate decisions about future care. It can also result in mismanagement of concommitant illnesses by interfering with a patient's ability to remember appointments, provide an accurate medical history, and take medication as prescribed.[4]

To address these issues, we developed a neurocognitive screening instrument that has the following characteristics: 1) It can be rapidly administered by allied health professionals in a primary care setting. 2) It requires minimal training and no clinical judgment. 3) It surveys multiple cognitive areas. 4) It can reliably distinguish between AD and cognitive deficits associated with the normal aging process. To develop the instrument, we evaluated the tests currently in use for mental status and neuropsychological assessment and identified those that were most sensitive for AD, could be rapidly administered by personnel with little training, and could be scored objectively. The resulting 7 Minute Screen™ consists of a battery of four tests, each of which focuses on an area of cognition that is typically compromised in AD: orientation, memory, visuospatial ability, and expressive language.

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This study evaluates the validity and reliability of the 7 Minute Screen by comparing patients with probable AD with an age- and education-matched sample of normal, elderly subjects.

Methods

Allied health professionals administered the 7 Minute Screen to 60 normal, community-dwelling individuals and 60 AD patients referred to the Memory Disorders Clinic at Southwestern Vermont Medical Center (an affiliated clinic of the Massachusetts Alzheimer's Disease Research Center, where both authors hold clinical appointments). The study protocol was approved by our institution's human subjects review board. All subjects provided informed consent.

The 60 community-dwelling individuals had no history of head trauma, stroke, prior mental illness, mental retardation, life-threatening illness, psychiatric disorder, or neurologic disorder. To provide a preliminary evaluation of overall cognitive functioning, each completed the Blessed Information Memory Concentration Test.[5] A random subsample of 30 underwent more extensive neuropsychological testing, including the Mini-Mental State Examination[6] (MMSE) and several components of the Wechsler Memory Scale-Revised.

The 60 AD patients were consecutive referrals to our clinic that met National Institute of Neurological and Communicative Disorders and Stroke/Alzheimer's Disease and Related Disorders Association diagnostic criteria for AD,[7] based on 1) neurological, medical, psychiatric, and social examinations, 2) standard laboratory studies, 3) CT scans, 4) neuropsychological evaluations, and 5) history from a caregiver indicating at least a 1-year history of progressive cognitive decline. Results from the 7 Minute Screen did not contribute to their diagnosis.

The 7 Minute Screen

Orientation. As noted earlier, the 7 Minute Screen contains questions that focus on several aspects of cognition. These include orientation, memory, visuospatial skills, and expressive language (Appendix).

The portion of the 7 Minute Screen that focuses on orientation is the Benton Temporal Orientation Test (BTOT), which assesses a patient's ability to identify the month, date, year, day of the week, and time of day.[8] Unlike other mental status tests that have orientation as a component, the BTOT uses a graduated scoring system that reflects the degree of error. For example, a 1-day error in date results in an error score of only 1 point, whereas a 1-month error results in a score of 5 points. The maximum error score for the test as a whole is 113.

Table 1

Barriers to Alzheimer's Disease Diagnosis

- Patients and their caregivers do not typically report cognitive difficulties.[4]
- Cognitive difficulties may be masked by a continued ability to act in a socially acceptable manner.[19]
- Physicians fail to recognize early signs.[20,21]
- The mental status tests currently available are time-consuming, and the time required to administer them is unlikely to be reimbursed.
- Some of the most commonly used mental status tests[5,6] lack the sensitivity and/or specificity required for an accurate diagnosis.[22,23]
- In a small number of cases, co-morbid conditions (especially depression and delirium) can make differential diagnosis problematic.[18]

Memory. The portion of the 7 Minute Screen that focuses on memory is an abbreviated version of the Enhanced Cued Recall Test, which consists of 16 items presented pictorially on four individual cards (four items per card).[9] While displaying the first card, the examiner gives a semantic cue and asks the patient to identify the picture on the card that best fits with the cue. (eg, Question: "There's a piece of fruit on this page, what is it?" Answer: "Grapes.") When the patient successfully identifies all four items, the examiner removes the card from view and immediately tests the patient's recall by again providing the cue and asking the patient to recall the item. After all four cards are presented, the examiner distracts the subject by asking him/her to recite the months of the year backwards. The examiner then asks the patient to recall as many of the items as possible without providing any cues. When the patient cannot recall any additional items, the examiner provides appropriate cues for the remaining items. This test distinguishes between AD and the memory deficits associated with the normal aging process, because normal elderly patients benefit more from reminder cues than do patients with AD. The score for this test is the total number of items remembered in both the uncued and cued recall, with a maximum score of 16.

Visuospatial Ability. The portion of the 7 Minute Screen that focuses on visuospatial ability is a clock-drawing test with a simplified scoring system based on that used by Freedman et al.[10] The examiner provides the patient with a pen and blank sheet of paper and says, "I want you to draw a clock with all the numbers on it. Make it large." When the subject finishes drawing the clock, the examiner asks him/her to draw the clock hands set at 20 minutes before 4 and determines a score based on the presence of seven attributes (eg, the hour hand is shorter than the minute hand, the hands are indicating the correct numbers, etc). The maximum score is 7.

Language. The portion of the 7 Minute Screen that focuses on expressive language is a test of verbal fluency.[11,12] The examiner asks the patient to name as many members of the category "animals" as possible over a 1-minute period. The score is the total number of appropriate items named.

Data Analysis. We used the Student's *t* test to determine if normal subjects and patients with AD differed significantly in their demographic characteristics and their neuropsychological test scores. The Student's *t* test was also used to determine if normal subjects and patients with AD differed significantly in mean scores on each of the four tests included in the 7 Minute Screen. The Pearson correlation coefficient was used to evaluate inter-rater and test-retest reliability.

To evaluate test-retest reliability, the 7 Minute Screen was readministered to a subsample of 25 randomly selected patients with AD and 25 randomly selected control subjects 1–2 months following the initial administration. To study inter-rater reliability, two raters scored the same testing session for a subsample of 25 randomly selected subjects with AD and 25 randomly selected controls. Two raters also scored all of the clocks (n=120), since it is the only portion of the battery that requires judgment to score.

To determine the degree to which the entire battery discriminated between control patients and patients with AD, we used a logistic regression, with the four individual tests serving as predictor variables.

We then tested the robustness of the model using two different strategies. First, we developed a logistic regression model based on a randomly selected subsample of 30 normal subjects and 30 patients with AD. We used this model to predict the status of the subjects not included in the subsample (the remaining 30 normal subjects and 30 patients). This process was repeated 1,000 times. Second, to determine how well the model predicted AD in those with less severe symptoms, we included only patients with MMSE scores $\geq$ 21 (n=35) in one analysis and only patients with scores $\geq$ 24 (n=13) in a second analysis. The positive and negative predictive values for hypothetical incidence rates of AD (5%, 10%, 20%, and 50%) were calculated using the sensitivity and specificity rates from the 1,000 random samples.

Results

Comparison of demographic data collected from normal subjects (n=60) and those with AD (n=60) indicated no significant differences in mean age, level of education, or gender distribution (Table 2).

Table 2

Demographic Characteristics

	Mean Patients With Alzheimer's Disease (n=60)	*Mean Normal Subjects (n=60)*	P *Value*
Education (years)	13.3	14.4	>.05
Age (years)	77.6	77.5	>.05
Gender (male:female)	20:40	21:39	>.05

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Comparison of neuropsychological test scores of normal subjects (n=30) and patients with AD (n=60) indicated that the control subjects performed significantly better than the AD patients on each test (Table 3).

When compared to the normal subjects, the patients with AD had significantly worse mean scores on each of the four tests included in the 7 Minute Screen (Table 4). For purposes of identification, we used the results of the logistic regression to calculate the probability of AD. We classified someone as having a high probability of AD if the logistic regression yielded a probability of $\geq$ .9, a low probability if the score was $\leq$ .1, and diagnosis was deferred if the probability was between .1 and .9. Based on logistic regression using 1,000 random samples, the battery correctly diagnosed 92% of the patients with AD and 96% of the normal subjects (Table 5).

When we included only patients with mild AD (MMSE $\geq$ 21) in the logistic regression, the battery correctly diagnosed 98% and 98% of the normal subjects. When we included only patients who scored in the "normal" range (MMSE $\geq$ 24) but actually had AD, the battery correctly diagnosed 98% of these

Table 3

Neuropschological Test Results

	Mean Patients With Alzheimer's Disease n=60 (SD)	*Mean Normal Subjects n=30 (SD)*	t *test*	P *Value*
MMSE	21.0 (7.8)	28.7 (2.1)	5.3	<.001
WMS-R LM1	4.8 (3.8)	22.7 (7.1)	15.4	<.001
WMS-R LM2	.3 (4.6)	18.7 (9.8)	12.3	<.001
WMS-R VR1	8.1 (5.4)	32.4 (6.6)	18.9	<.001
WMS-R VR2	4.1 (3.9)	28.3 (9.8)	16.9	<.001

MMSE—Mini-Mental State Examination
WMS-R—Wechsler Memory Scale-Revised
LM1—Logical Memory-1 LM2—Logical Memory-2
VR1—Visual Recall-1 VR2—Visual Recall-2

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Table 4

Individual Tests

	Mean Patients With Alzheimer's Disease n=60 (SD)	*Mean Normal Subjects n=60 (SD)*	t *test*	P *Value*
BTOT	37.9 (4.2)	.4 (.1)	8.8	<.001
Enhanced Cued Recall Test	6.8 (.7)	15.9 (.4)	13.9	<.001
Clock-drawing Test	3.2 (.3)	6.3 (.1)	11.6	<.001
Verbal Fluency	8.8 (.5)	19.0 (.7)	11.9	<.001

BTOT—Benton Temporal Orientation Test

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patients and 100% of the normal subjects. We also considered a model using age, years of education, and gender. Adding these variables to the logistic regression did not change sensitivity or specificity. Finally, the positive predictive values for hypothetical incidence rates of AD (5%, 10%, 20%, and 50%) ranged from 55%–96%, and the negative predictive values ranged from 92%–99% (Table 6).

Reliability

Test-retest reliability indicated that each of the four tests included in the 7 Minute Screen was highly reliable (orientation, r=.93; memory, r=.92; clock drawing, r=.84; and verbal fluency, r=.83). Overall test-retest reliability for the battery of tests was also high (r=.91), based on the predicted probability of dementia from the logistic regression of the battery. Inter-rater reliability for the battery of tests was also highly reliable (r=.93), as was inter-rater reliability for visuospacial ability (clock drawing) (r=.92).

Testing Time

The mean time required to administer and score the screen was 7 minutes, 42 seconds, with a range from 6 minutes, 40 seconds to 11 minutes, 32 seconds. The patients with AD took somewhat longer to complete the battery than did the normal subjects.

Discussion

The data collected in this study indicate that the 7 Minute Screen is a reliable and valid instrument for identifying patients with AD. It is highly sensitive, as evidenced by its ability to identify 92% of patients with AD in 1,000 random samples taken from the total group. It is also highly specific, as evidenced by its ability to identify 96% of the normal subjects in the same sample. The battery's sensitivity and specificity remained high, even when patients with only mild and very mild AD were included in the sample. Mean time to administer and score the screen was 7 minutes, 42 seconds.

These data compare favorably with the sensitivity and specificity reported by a meta-analysis of the MMSE, one of the most commonly used tests of mental status in elderly patients.[13] In fact, when used to evaluate a sample of patients with mild and very mild AD, the 7 Minute Screen performed better than the MMSE. Additionally, the specificity of the MMSE appears to be compromised when used with patients with less than an eighth grade education[14] or with high levels of education,[15] whereas the 7 Minute Screen was not affected by subjects' level of education, age, or gender.

Test-retest reliability was high, with correlation coefficients similar to those found with the MMSE over short intervals (ie, minutes, hours, and days)[13] and better than those found with the MMSE over a period of 1–2 months.[16,17] Inter-rater reliability was also high.

Based on the data presented in this study, the 7 Minute Screen appears to be a promising instrument for rapid detection of AD patients by allied health professionals with minimal training. However, a number of practical questions remain. Additional research is required to determine if the 7 Minute Screen 1) is valid and reliable when used in a primary care setting, 2) is sensitive to other dementing disorders, and 3) can distinguish AD from other dementing disorders and clinical levels of depression.

Table 5

Mean Predictions from Logistic Regression for 1,000 Iterations

Diagnosis	*Alzheimer's Disease*	*Normal Subjects*
Diagnosed correctly	92%	96%
Diagnosis deferred	3%	3%
Diagnosed incorrectly	5%	1%

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Table 6

Positive and Negative Predictive Values

Base Rate	*Positive Predictive Value*	*Negative Predictive Value*
5	55%	99%
10	72%	99%
20	85%	98%
50	96%	92%

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We have recently undertaken a study to evaluate the validity and reliability of the 7 Minute Screen in a primary care setting. Preliminary results indicate a high degree of sensitivity, suggesting that the screen can be used to identify previously undiagnosed cases of AD. Of the 137 patients screened in a 7-week period, 13 were identified as having a high probability of dementia. Ten of the 11 patients who agreed to return for more extensive evaluation were subsequently diagnosed with probable AD. When these data are extrapolated over a 1-year period, they reflect approximately 75 patients whose AD would have been undiagnosed.

All the materials necessary for administering and scoring the 7 Minute Screen are available on request and at no charge at http://www.phin.org or from Dr Solomon. Distribution of these materials is supported by Janssen Pharmaceutica Research Foundation.

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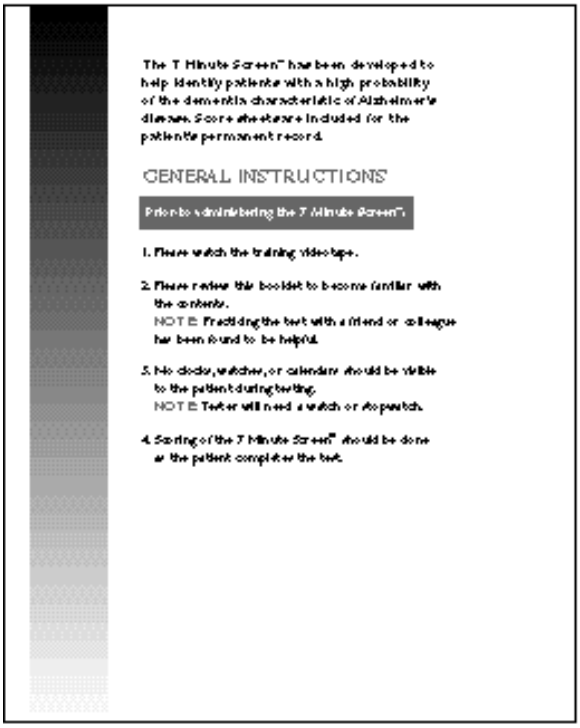
Editor's Note: This paper was awarded first prize at the American Academy of Family Physicians 1997 Annual Scientific Assembly in Chicago in the category of "research by individuals not affiliated with family medicine departments."

Appendix

Examples of Instructions, Scoring Sheets, and Stimulus Materials for the 7 Minute Screen

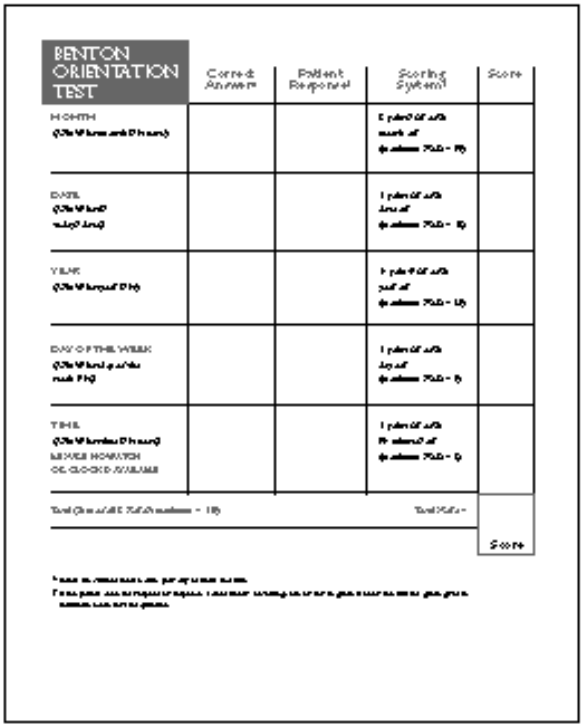


The 7 Minute Screen™ has been developed to help identify patients with a high probability of the dementia characteristic of Alzheimer's disease. Score sheets are included for the patient's permanent record.

GENERAL INSTRUCTIONS

Prior to administering the 7 Minute Screen™:

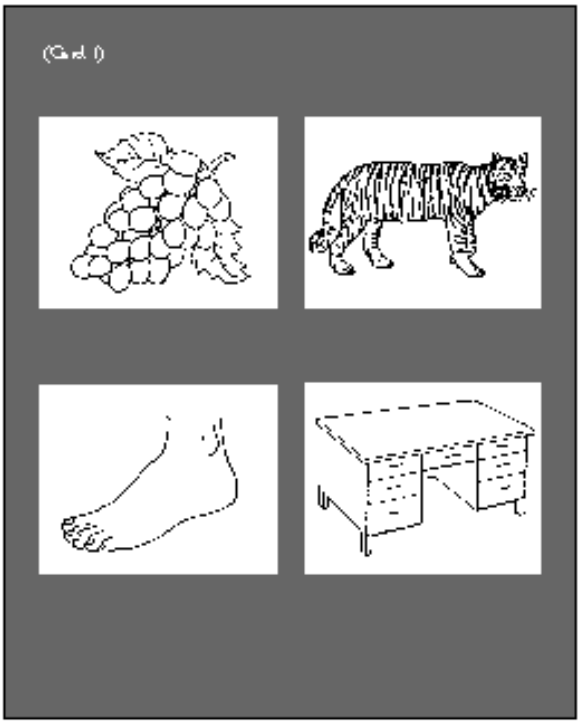
1. Please watch the training videotape.
2. Please review this booklet to become familiar with the contents.
   NOTE: Practicing the test with a friend or colleague has been found to be helpful.
3. No clocks, watches, or calendars should be visible to the patient during testing.
   NOTE: Tester will need a watch or stopwatch.
4. Scoring of the 7 Minute Screen™ should be done as the patient completes the test.



BENTON ORIENTATION TEST

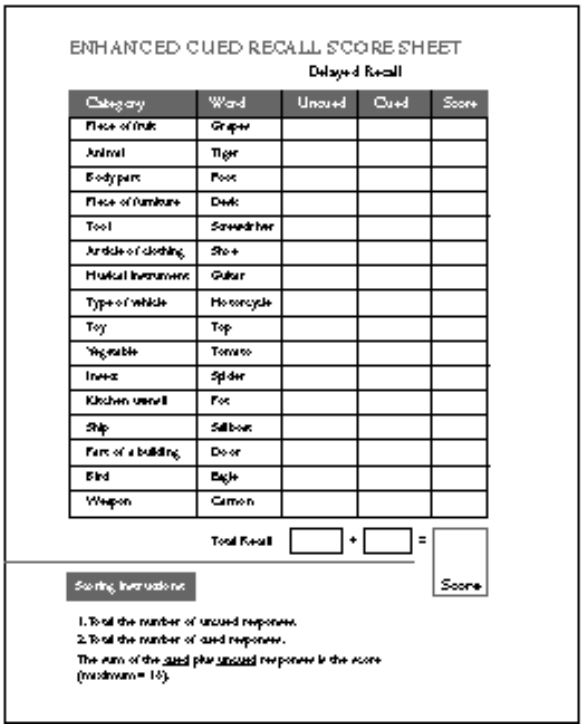
	Correct Answer	Patient Response	Scoring System	Score
MONTH				
DATE				
YEAR				
DAY OF THE WEEK				
TIME				

Score



(Card I)

Panel 3: Stimulus materials for the Enhanced Cued Recall Test



ENHANCED CUED RECALL SCORE SHEET

Delayed Recall

Category	Word	Uncued	Cued	Score
Piece of fruit	Grape			
Animal	Tiger			
Body part	Foot			
Piece of furniture	Desk			
Tool	Screwdriver			
Article of clothing	Shoe			
Musical instrument	Guitar			
Type of vehicle	Motorcycle			
Toy	Top			
Vegetable	Tomato			
Insect	Spider			
Kitchen utensil	Fork			
Ship	Sailboat			
Part of a building	Door			
Bird	Eagle			
Weapon	Cannon			

Total Recall [ ] + [ ] = Score

Scoring Instructions

1. Total the number of uncued responses.
2. Total the number of cued responses.

The sum of the cued plus uncued responses is the score (maximum = 16).

Panel 4: Score sheet for the Enhanced Cued Recall Test

(Appendix continued on next page)

Appendix (continued)

The 7 Minute Screen

PLACE THE BOOK FLAT ON THE SURFACE IN FRONT OF YOU.

As the patient draws the clock, score the clock according to the instructions on page 3/4.

CLOCK DRAWING

GIVE the subject a blank piece of paper and a pen.

SAY: "I want you to draw the face of a clock with all the numbers on it. Make it large."

After the patient has drawn the face of a clock,
SAY: "Now draw the hands, pointing at 20 minutes before 4 o'clock."

Follow the instructions for scoring on the next page.

CLOCK DRAWING SCORESHEET

SCORE the clock by giving one (1) point for each correct component (as described on the score sheet below).

1._____ Only numbers 1–12 are present (Arabic or Roman)
- Incorrect if missing any number between 1 and 12
- Incorrect if numbers other than 1 through 12 exist
- Incorrect if extraneous numbers (such as "20") are present

2._____ Numbers in correct order
- Numbers must always be increasing
- Numbers do not have to reach "12"

3._____ Numbers in correct position
- Mentally divide the clock into 4 quadrants with 3 numbers in each
- Numbers should be appropriate for that quadrant (eg, 1, 2, 3 in upper right quadrant)

4._____ 2 hands are present
- Must use hands — darker or circled numbers are incorrect

5._____ Hour ("H") number is indicated
- May be indicated by small darker or circled numbers
- Must be closer to "H" than to any other number

6._____ Minute target number indicated
- May be indicated by small darker or circled numbers
- Must be closer to "M" than to any other number

7._____ Hands in correct proportion (hour hand shorter than minute hand)
- Patient may indicate that "this (hour) hand is smaller"

Score (maximum = 7)

Score

VERBAL FLUENCY SCORESHEET

Make a check mark [✓] for each correct response in the lines below. Each check [✓] = 1 point.

1._____	16._____	31._____
2._____	17._____	32._____
3._____	18._____	33._____
4._____	19._____	34._____
5._____	20._____	35._____
6._____	21._____	36._____
7._____	22._____	37._____
8._____	23._____	38._____
9._____	24._____	39._____
10._____	25._____	40._____
11._____	26._____	41._____
12._____	27._____	42._____
13._____	28._____	43._____
14._____	29._____	44._____
15._____	30._____	45._____

Score

Scoring: Record the number of the last line checked in the score box.

Panel 7: Scoring sheet for the Verbal Fluency Test

SCORING SUMMARY

TEST	RANGE	SCORE
Benton Orientation	115-0*	
Enhanced Cued Recall (ECR)	0-16*	
Visuospatial (Clock Drawing)	0-7*	
Verbal Fluency (Animals)	0-45*	

* = Perfect Score

Enter these scores into the calculator to determine the patient's probability rating.

It is suggested that results be provided to the physician for discussion with the patient.

- If the calculator reads "hi," the probability that the patient has dementia characteristic of Alzheimer's disease is high.
- If the calculator reads "lo," the probability that the patient has dementia characteristic of Alzheimer's disease is low.
- If the calculator reads "?," there is insufficient data to make a judgment. It would be advisable to rescreen in 6 to 9 months.

Circle the patient's probability rating on the "7 Minute Screen" scoring summary sheet. This sheet could be placed in the patient's medical record.

Panel 8: Scoring summary for the four tests comprising the 7 Minute Screen