

**DEMENTIA RATING SCALE PERFORMANCE: A COMPARISON OF
VASCULAR DEMENTIA ASSOCIATED WITH SINGLE CEREBRAL
INFARCTION, MULTIPLE INFARCTIONS, AND SUBCORTICAL SMALL
VESSEL DISEASE**

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ABSTRACT

We investigated neuropsychological dysfunction associated with vascular dementia (VaD). The cognitive performance of patients with subcortical small vessel white matter disease was contrasted with that of patients having either a single or multiple large vessel cortical infarctions.

Methods. Patients with single stroke (CVA), multiple infarctions (MI), and small vessel white matter disease (WMD) were compared on the Dementia Rating Scale (DRS). Three VaD groups (CVA, MI, WMD) were contrasted to age-matched normal control subjects, and Alzheimer's disease (AD) patients. DRS-total score was initially compared across groups for all patients. Pattern of DRS subscale impairment was then compared across groups for those patients who met the criteria for dementia (DRS < 124).

Results. A majority of CVA (78.6%) and MI (85.1%) patients had DRS impairment that met criteria for dementia, while approximately half of WMD (54.3%) met these criteria. 93.6% of AD patients met the DRS dementia criteria, while none of the Control subjects did. MI patients did not differ from AD patients in DRS-total score, whereas the CVA and WMD patients were less impaired than AD patients, but more impaired than Controls. Regarding pattern of performance in patients who met dementia criteria, WMD, CVA and MI patients performed similarly, with greatest relative impairments on Initiation/Perseveration and Construction. In contrast, AD patients had greatest impairments on the Memory subscale.

Discussion. Regardless of diagnostic group, VaD patients were most impaired on frontally mediated functions (initiation/perseveration), compared to the AD patients who had greatest impairments related to memory functions. These findings have implications for the assessment and differential diagnosis of VaD.

Key Words: Dementia Rating Scale, Alzheimer's Disease, Vascular Dementia, Stroke, Neuropsychological Impairments

While Alzheimer's Disease (AD) is the most widely recognized type of dementia, patients with cerebrovascular disease also commonly experience impairments across multiple cognitive domains and meet criteria for a diagnosis of dementia. Growing awareness that a relationship between the occurrence of multiple cerebral infarctions and dementia led to the development of a diagnostic category for multi-infarct dementia (MID) in DSM-III. Eventually, a broader diagnostic category of vascular dementia (VaD) was included in DSM-IV, in recognition of the fact that various cerebrovascular disorders can cause dementia.

Even though VaD often occurs due to the cumulative effect of multiple infarctions caused by sequential strokes (Wolfe et al., 1994), multiple large vessel infarctions are not a necessary precondition for the development of VaD. Patients with multiple small lacunar infarctions frequently exhibit global cognitive dysfunction (Mielke et al., 1992). VaD may also occur following a single large vessel stroke (CVA), as recent investigations have demonstrated that a single infarction that produces a large lesion or that effects critical cortical areas is sufficient to cause dementia (Tatemichi et al., 1994; Cohen & Kaplan, 1996). Cerebral microvascular disease also causes subcortical white matter damage (leukoareosis) and associated cognitive changes that may be sufficient to warrant a diagnosis of dementia (Cummings, 1993). Though the neuropathological bases of leukoareosis is still not fully understood, global cerebral ischemia associated with cardiovascular and peripheral-vascular disease appears to be major contributing factor. In sum, VaD may result from different cerebrovascular processes, ranging from single infarctions associated with large vessel CVA to subcortical WMD resulting from chronic cerebral ischemia.

Considerable progress made over the past decade in delineating the unique etiologies of these types of VaD dementia. Distinguishing between subtypes of dementia depends on consideration of multiple etiologic, neuropathological and clinical findings. Neuropathological analysis of brain tissue from patients with dementia, in conjunction with clinical data, still provides the best means of differentiating VaD from AD. Unfortunately, brain biopsy of patients with dementia is usually not feasible, and post-mortem data is necessary to make a definitive diagnosis. In the absence of neuropathological data, differential diagnosis of VaD from AD depends on consideration of cerebrovascular history, clinical course, and neuropsychological findings. Unfortunately, relatively few studies have examined how neuropsychological dysfunction varies as a function of VaD etiology.

Cortical infarctions associated with a single CVA often produce focal cortical lesions that may produce specific impairments, which may be limited to one domain of cognitive functioning. The unique syndromes resulting from such lesions served as the foundation for the field of neuropsychology. Yet, more often than not, neuropsychological syndromes do not occur in isolation, but rather are associated with a cluster of impairments, often involving multiple cognitive domains. For instance, left hemisphere infarctions that cause aphasia, also may result in apraxia, learning and memory problems, or executive dysfunction. Accordingly, global cognitive dysfunction after a single CVA may occur as the byproduct of a mixture of different syndromes. The location and volume (i.e., mass action) of the cerebral infarction is a major determinant of the syndrome that develops, and whether dementia will result (Wolfe et al., 1994; Mielke et al., 1992). The severity of cognitive deficits associated with VaD has been shown to be directly related to the total volume of hypometabolic brain tissue as measured by positron emission tomography (PET), suggesting that the total extent of brain injury is a critical determinant of severity of cognitive impairments (Mielke et al., 1992). Accordingly, the diagnosis of VaD is less a function of the presence of multiple infarctions than of the location and size of the lesions.

The relationship between infarction characteristics and neuropsychological presentation is more complicated for patients with WMD. In general terms, severity of WMD is a function of the extent of leukoencephalopathy. Significant cognitive dysfunction does not appear to emerge until a critical threshold of white matter involvement is reached (refs). However, localization of lesion effects in WMD is more difficult to analyze.

In the present study, we investigated cognitive dysfunction associated with three VaD subtypes (CVA, MI, WMD) on the Dementia Rating Scale (Mattis, 1988). Our goal was to determine whether severity and pattern of cognitive dysfunction varied as a function of VaD subtype. We hypothesized that patients with MI would exhibit the greatest overall severity of impairment, though with less memory dysfunction. We hypothesized that the three VaD subgroups would exhibit similar patterns of impairment, with the WMD group being the least impaired. For WMD patients, greatest impairment was expected on the Initiation/Perseveration subscale, reflecting disruption of frontal/subcortical pathways.

METHODS

SUBJECTS. The study sample consisted of 240 patients who had been referred for outpatient neuropsychological evaluation at medical centers located in three New England states (Brown University-Miriam Hospital (MH), Maine Medical Center (MM), Tufts-New England Medical Center (NEMC), and University of Massachusetts Medical Center (UMMC). All patients were referred for an initial neuropsychological assessment of problems involving cognitive and/or memory functioning. The neuropsychological assessment was conducted at least one month after their most recent cerebrovascular event, or within one month of their receiving an initial diagnosis of AD. Diagnoses were made on the basis of neurological, neuropsychological, and neuroradiological report data (brain MRI).

Vascular Dementia (VaD). The VaD group consisted of three subgroups comprised of CVA, MI, and WMD disease patients. Patients were excluded from these subgroups if they showed evidence of significant cortical atrophy, a gradual insidious and progressive decline in cognitive functioning, and other clinical findings consistent with AD. Patients who exhibited possible VaD or evidence of mixed dementia (AD + VaD) were excluded. For CVA, MI, and WMD patients, a diagnosis of VaD was if NINCDS-ARIEN criteria were met, with existence of global cognitive dysfunction indicative of dementia, and a clinical course consistent with VaD.

Single stroke (CVA). The CVA group (n=87) consisted of patients who had suffered a single large vessel embolic, thrombotic, or hemorrhagic stroke involving the vascular territories of the middle, anterior, or posterior cerebral arteries, or one of the major subcortical vessels. The location and extent of these infarctions was determined based on neuroradiological reports of brain MRI. Table 1 provides a characterization of the percentages of patients exhibiting infarctions in each hemisphere and in each cortical region. (Table 1)

Multiple Infarctions (MI). The MI group (n=42) consisted of patients with evidence of two or more discrete cerebral infarctions that had occurred at different time points, as documented by medical history, and neuroradiological (MRI) findings. For MI patients, the extent and location of cortical damage was characterized as a function of the cortical lobes affected by infarction, as shown in Table 1.

White Matter Disease (WMD). This group consisted of patients without prior cortical lesions associated with CVA, and no evidence of current large vessel infarction (n=48). WMD

patients were required to have moderate to severe subcortical leukoareosis on MRI, with evidence of minimal cortical atrophy, and a clinical course inconsistent with AD.

Alzheimer's Disease (AD). A diagnosis of AD was made according to NINCDS-ADRDA guidelines for probable AD (McKhann, Drachman, Folstein, et al., 1984). All patients in this group (n=63) had a MMSE score of less than 25, and deficits in memory and two other cognitive domains. MRI findings of greater than expected atrophy for age was required, as well as the absence of evidence of prior cortical infarctions, indicative of prior stroke. All patients in this group had evidence of an insidious onset, gradual progression, and a decline in functional ability relative to estimated premorbid levels. The AD diagnosis was given based on unanimous agreement of clinicians in the Memory Disorder Clinic. Patients with a history of neurological brain disease, including prior CVA were not included in the AD sample. Patients with evidence of mixed dementia (AD + VaD) based on history of previous CVA were excluded. Patients with mild to moderate leukoareosis that was not disproportionate to atrophy on MRI were retained in the AD group, if they had a clinical history consistent with AD, minimal risk factors for VaD, and no known history of cerebrovascular disease.

Controls. Age-matched non-neurological patients (n=58) served as a control group. They consisted of patients from a rehabilitation service who were not being treated for neurological brain disorders, and medical outpatients, without known neurological disease.

MEASURE. The Dementia Rating Scale (DRS) was administered to each patient (Mattis, 1988). The DRS is a commonly used brief neuropsychological screening test used to assess cognitive dysfunction and decline, including the presence of dementia in elderly adults (Lezak, 1995). The DRS provides a severity index of cognitive dysfunction and is useful in determining whether a patient meets the criteria for dementia. In addition to an index of severity of global cognitive dysfunction, the DRS provides five subtest scores that can help determine whether impairment is present in specific areas of cognitive functioning, including attention, initiation/perseveration, conceptualization, construction, and memory. The memory subtests consist of verbal and visual recall and recognition tasks. Thus, data from the subscales provide information about patterns of cognitive dysfunction relative to level of global dementia. A cutoff score of 123 on the DRS reflects performance that is two standard deviations below the mean for elderly individuals (DRS Total = 137.3 ± 6.9 ; mean \pm SD), and is considered to be

indicative of dementia. Extensive normative data on the DRS exist, largely for diagnosing AD in settings ranging from community samples (Monsh et al, 1995) to nursing homes (Nadler et al., 1995). The clinical validity and utility of the DRS has been well established, not only for the diagnosis of AD, but also for predicting which patients with

The DRS has several advantages over other brief dementia screening instruments such as the Mini-Mental Status Examination (MMSE). The DRS covers a wider range of cognitive functions and provides a more sensitive index of severity of cognitive dysfunction. The five subscales of the DRS (Attention, Initiation/Perseveration, Construction, Conceptualization, Memory) enable the clinician to identify specific domains of cognitive impairment that stand out relative to global dysfunction that may exist. The Memory subscale consists of two memory measures: free recall and recognition. Near perfect scores are typical for intact elderly control subject subclinical memory impairments are likely to subsequently develop AD (Troster et al., 1995).

Several of the subscales have been shown to be particularly sensitive in discriminating between cortical and subcortical dementia (Salmon et al., 1989; Rosser & Hodges, 1994; Vander Hurk & Hodges, 1995; Paulsen et al., 1995). For example, patients with Huntington's Disease (HD) and AD, exhibit different subscale performance, as AD patients are most impaired on the Memory scale, while HD patients are most impaired on Initiation/Perseveration scale (Salmon et al., 1989). This difference in the pattern of performance between HD and AD persists after patients are stratified according to level of dementia suggesting that subscale differences between groups are independent of dementia severity (Paulsen et al., 1995). The Initiation/Perseveration scale was also shown to discriminate between Progressive Supranuclear Palsey (PSP) and AD in patients matched for dementia severity, suggesting that this subscale may be sensitive to a wide range of subcortical dementia (Rosser & Hodges, 1994; Paulsen et al., 1995).

PROCEDURE. The DRS was administered to all patients as part of a more comprehensive neuropsychological evaluation. Administration of the DRS was conducted in the standard manner. Following test administration, each patient's chart was reviewed and pertinent clinical and neurodiagnostic information placed into the database. The neuroimaging report from the MRI was then reviewed and rated for severity of leukoareosis and/or subcortical lesions.

RESULTS

PATIENT CHARACTERISTICS. Age did not differ significantly between groups ($p > .05$; AD = 74.84 ± 6.38 , CVA = 72.6 ± 9.05 , MI = 75.94 ± 7.75 , WMD = CONTROL = 75.66 ± 5.60).

Gender differed across clinical groups, as the proportion of males was greater for the CVA (67.4%), MI (59.3%), and WMD (52.0%) groups than the AD group (38.3%), while controls had a roughly equal proportion of each gender (51.2% male). Education level also did not differ between groups ($p = .94$; AD = 11.4 ± 3.7 , CVA = 11.7 ± 3.5 , MI = 11.6 ± 3.2 , WMD = 12.0 ± 2.80 Controls = 12.25 ± 1.86).

OVERALL DRS PERFORMANCE AS A FUNCTION OF DIAGNOSTIC GROUP. A between group ANOVA comparison of DRS-Total revealed a highly significant difference between groups ($F(4,294) = 5.988$, $p = .0001$), with the clinical groups impaired compared to normal control subjects. All patient groups were significantly impaired compared to Controls, and mean DRS-Total score for each of these groups fell below the clinical cutoff for dementia diagnosis (DRS-Total < 124), whereas Controls performed within normal limits and well above this clinical cutoff score. In light of this finding, the Control group was not included in subsequent analyses, so that between-group differences among patients could be more easily interpreted. (Table 2).

AD and MI patients did not differ with respect to DRS-Total ($p = .46$), whereas AD patients were more impaired than both CVA ($p = .002$) and WMD ($p = .00001$) patients. VaD patients were more impaired than WMD patients ($p = .0004$), but showed only a trend towards greater impairment compared to CVA patients ($p = .08$). Table 2 illustrates the performance of these groups across the primary DRS indices (mean \pm SD).

VaD subgroups compared to AD. A MANOVA comparing groups across the five DRS subscales revealed a highly significant difference in DRS performance (Wilks' $\lambda = .69$, $F(15, 480) = 4.45$, $p < .000001$). Groups differed across each of the DRS subscales. Largest differences were observed with respect to DRS-Memory performance ($F(3, 178) = 10.25$, $p = .000003$), as AD patients exhibited greatest impairments compared to MI ($p < .001$), CVA ($p < .00001$), and WMD ($p < .000001$). AD patients were more impaired than WMD patients across all other DRS subscales. AD patients were more impaired than MI patients only on DRS-Memory subscale, and MI patients actually showed greater impairment than AD patients on the DRS-Construction subscale ($p = .01$). Besides DRS-Memory, AD patients were more impaired than CVA patients with respect to DRS-

Conceptualization ($p=.0001$) and Attention ($p=.03$), but were slightly less impaired with respect to DRS-Construction ($p=.05$).

To control for the fact that groups differed with respect to severity of dementia as measured by DRS-Total Score, the analyses were repeated for patients who met the criteria for probable dementia (DRS-Total Score < 124). The vast majority of AD patients (93.4%), and 70% of single CVA and 78% of MI patients met this DRS dementia criterion. Among WMD patients, 54.6% of the group met this criterion. An ANOVA that compared DRS-Total Score across groups did not reveal significant differences ($p>.28$), indicating that overall severity of dementia was similar among these subgroups. However, MANOVA revealed significant between group differences across the five DRS-subscales (Wilk's Lambda = .70; $F(15, 480) = 4.45$, $p<.0001$). AD patients exhibited much greater DRS-Memory impairments than CVA ($p<.0002$) and WMD ($p<.0009$) patients, but showed only a trend towards greater impairment compared to MI patients ($p=.07$). AD patients also had greater impairments on DRS-Conceptualization compared to WMD patients ($p=.004$), but not compared to CVA or MI patients. AD patients did not differ from the other groups with respect to DRS-Attention or DRS-Initiation, and were actually less impaired than the MI ($p=.02$), and CVA ($p=.01$) groups on DRS-Construction.

PATTERN OF DRS PERFORMANCE ACROSS VaD SUBGROUPS

Performance on the five DRS subscales was next contrasted across the three VaD subgroups. Again only patients with $DRS<124$ were included in this analysis to control for severity of impairment. The MANOVA revealed an overall statistically significant difference among the three groups (Wilk's Lambda=.84, $F(10,232)=1.92$, $p=.05$). WMD patients had less impairment than MI patients on DRS-Conceptualization ($p=.01$), DRS-Initiation ($p=.01$), and DRS-Attention ($p=.03$), as well as a trend towards less impairment on DRS-Construction ($p=.08$). CVA patients also showed stronger DRS-Initiation performance compared to MI patients ($p=.02$), and a trend towards stronger performance on DRS-Memory ($p=.08$). The CVA and WMD groups did not differ on any DRS subscales.

The pattern of impairment across DRS subscales was next analyzed for the three VaD groups. A ranking was assigned, such that the subscale with that was most impaired for each subject was given a rank of 5, the next most severe was given a rank of 4, to the least severe which was assigned a rank of 1. A "test of rank order" was then conducted to determine

whether the groups differed with respect to relative severity ranking for each of the DRS subscales. No statistically significant between group differences were found in rankings for any of the DRS subscales, indicating that the three VaD groups exhibited a similar pattern of impairment. (Figure 1)

NEUROPSYCHOLOGICAL IMPAIRMENTS AS A FUNCTION OF INFARCTION

CHARACTERISTICS. Analysis of the effect of lesion laterality revealed only trends towards greater impairment for patients with cortical infarctions involving the left hemisphere as compared to the right hemisphere for both CVA ($p=.07$) and MI ($p=.10$) with respect to overall DRS performance across the five subscales. However, among MI patients, bilateral infarctions were associated with greater DRS-total impairment than infarctions affecting only one hemisphere ($F(2, 38) = 2.23, p=.01$).

DRS-Total impairment also showed a trend towards greater impairment as a function of number of lesions ($p=.10$). While no difference in dementia severity was observed in patients having either one or two infarctions, patients having three or more lesions showed greater impairment than patients having only one lesion ($p<.01$).

Given the heterogeneity of lesion locations, it was not possible to perform statistical analyses to compare specific cortical areas of damage. However, patients were divided into two groups on the basis of whether their infarction affected anterior brain systems (frontal, anterior temporal, anterior parietal lobes), or posterior brain systems (occipital, posterior parietal lobes). A statistically significant difference was found, as patients with anterior cortical lesions exhibited greater DRS-Total impairment than patients with posterior cortical lesions ($F(1,36)=3.20, p<.001$).

DISCUSSION

This study demonstrates that severe cognitive dysfunction frequently occurred in patients with cerebrovascular disease irrespective of whether they had a single cortical infarction (CVA), multiple infarctions (MI), or subcortical white matter ischemic disease (WMD). The proportion of patients who met the criterion for dementia based on DRS-Total Score was roughly equivalent for MI and CVA patients, suggesting that the occurrence of multiple infarctions is not a prerequisite for the development of VaD. This finding is generally consistent results from other

recent studies that have demonstrated a high incidence of dementia among patients with cortical infarctions. These studies suggest that the development of dementia is a function of the total quantity of cortical damage and the brain regions affected, rather than the number of infarctions per se. From a clinical perspective, this finding suggests that the concept of multi-infarct dementia may have outlived its usefulness.

While dementia occurred at a somewhat lower rate in the WMD group, a majority of WMD patients also met DRS dementia criterion. Patients in this group had evidence of moderate to severe leukoencephalopathy based on neuroradiological analysis of brain MRI. Patients were not included in this group if they had a clinical history suggestive of AD, including insidious symptom onset, slow progressive cognitive decline, or evidence of significant cortical atrophy, disproportionate to the amount of white matter damage. Furthermore, all WMD patients had significant risk factors for cerebrovascular disease. Accordingly, the WMD group was relatively free of confound due to AD, at least to extent allowable through current diagnostic methods. That a sizeable proportion of patients in the WMD group met dementia criteria lends support to the existence of a subtype of VaD associated with subcortical small vessel white matter disease.

The percentage of patients who met the DRS dementia criterion in our sample was somewhat higher than described in some previous studies (Tatemichi.), probably due to the method of sampling. The present study was not designed to evaluate the incidence of dementia among different cerebrovascular disease subgroups. Instead, patients were selected who had been referred for outpatient neuropsychological assessment, either in the context of rehabilitation, or a cognitive-memory disorders program. Presumably patients who had experienced stroke or other cerebrovascular events without significant cognitive change were never referred for an assessment. On the other hand, these patients were not referred because of specific concern over whether they had VaD, or for a dementia work-up, but rather in most cases because of problems involving particular cognitive functions. Since patients with aphasia were excluded, the finding of dementia in these groups was not simply a function of the ability of patients to comply with the testing. Therefore, the results illustrate that regardless of the specific cognitive problems that may have been evident, dementia was a common outcome in these groups.

The second issue addressed in this study was whether the pattern of cognitive dysfunction varied as a function of cerebrovascular group, or between VaD and AD patients. For these analyses, we included only patients who met DRS dementia criterion, which allowed for comparison of groups comparable with respect to severity of cognitive dysfunction. Patients from the cerebrovascular subgroups included in these analyses met the criteria for VaD, with sufficient cognitive impairment across domains to be considered demented. These analyses revealed that AD patients had a different pattern of DRS impairment compared to the three VaD subgroups with their greatest impairment involving memory and then conceptual functions. In contrast, patients across the three VaD subgroups had their greatest impairments on the Initiation-Perseveration subscale, with Constructional ability being the next greatest domain of impairment. That patients with VaD had their greatest difficulty on tasks involving executive functions suggests that frontal-subcortical dysfunction may be more common in this group.

Interestingly, the pattern of cognitive impairment across DRS subscales was quite similar for the three VaD subgroups. While the MI patients had greater impairments on several measures than the WMD patients, Significant neuropsychological dysfunction was evident in a The DRS demonstrated identify a great majority of patients with AD and VaD (MI, single CVA). Most patients from each of these diagnostic groups performed over two standard deviations below expected levels for their age, thereby meeting the criteria for diagnosis of dementia. Almost all patients with AD (93%), and a majority of patients with VaD (70% of CVA, 78% of MI) met the DRS criteria for dementia. Accordingly, the present findings indicate that the DRS are not only a useful test for assessing dementia among AD patients, but that it also is sensitive to VaD among patients with a single CVA and MI.

The present results support our initial predictions regarding comparisons of AD and VaD patients on their DRS performance. Although the AD and VaD groups could not be differentiated on the basis of their overall performance on the DRS, differences between AD and VaD subgroups were demonstrated on the DRS subscales: Memory, Initiation/perseveration, and Construction. With respect to memory, AD patients showed a specific pattern of impairment, with memory being the most impaired function. Specifically, compared to the other groups, AD patients had the greatest deficit both on free recall and recognition memory testing formats. For example, on free recall, AD patients typically recalled approximately 14% of verbal information while MI and CVA patients typically recalled approximately 57% of the same

information. Therefore, AD patients exhibited severe amnesia, with minimal, whereas CVA and MI, although impaired, were still capable of recalling about half of the information. On the other hand, MI and CVA patients showed a specific pattern of impairment on frontally mediated functions (initiation/perseveration) and construction, as compared to the AD group. These findings of amnesia in AD patients and severe impairment of frontal functions in VaD are consistent with our original expectations.

These finding supports results from other studies of CVA associated cognitive impairment (Tatemichi et al., 1994; Cohen & Kaplan, 1996), which have suggested that multiple cerebral infarctions are not a prerequisite for the VaD diagnosis, since a single CVA can produce severe cognitive dysfunction consistent with dementia. These findings are of clinical significance, as the presence of impairments across multiple domains has often been interpreted to reflect either AD or MI. That a single large vessel CVA is also capable of producing global cognitive dysfunction with severity similar to that seen in AD and MI patients suggests that clinicians need to consider the possibility of dementia in all patients with a major cerebrovascular event

As a noteworthy observation in the present study we would like to point to the finding of significant levels of white matter microvascular ischemic disease or leukoareosis, not only among CVA and MI patients, but also among about 50% of the AD sample. The high prevalence of leukoareosis among CVA and MI patients is consistent with the phenomenology of stroke (cerebral infarctions that damage large vascular territories are likely to involve subcortical white matter). The high frequency of leukoareosis among AD patients is more difficult to explain, as there is not a simple explanation for such pathology. Investigators have reported amyloid changes in the white matter of AD patients, though the significance of these changes is not yet well understood. For CVA, MI, and AD patients, the specific contribution of leukoareosis is difficult to determine, as the neurobehavioral impact of white matter disease is usually nested within other severe abnormalities associated with cortical infarction or degeneration.

In summary, the DRS is a useful screening measure of dementia, as demonstrated by its sensitivity to cognitive impairments in AD and VaD subgroups. While the overall DRS score did not differentiate between AD and most VaD subgroups, differences between AD and VaD subgroups were demonstrated on the DRS subscales. The best differentiating subscales were Memory, Initiation/perseveration, and Construction. Memory deficits are particularly sensitive

in identification of AD, while problems with construction and frontal lobe functions point to VaD.

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