Executive Dysfunction and Long-term Outcomes of Geriatric Depression

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Background: This study investigated the relationship of executive and memory impairment to relapse, recurrence, and course of residual depressive symptoms and signs after remission of geriatric major depression.

Methods: Fifty-eight elderly subjects remitted from major depression received continuation nortriptyline treatment (plasma levels 60-150 ng/mL) for 16 weeks and then were randomly assigned to either nortriptyline maintenance therapy or placebo for up to 2 years. Diagnosis was made using the Research Diagnostic Criteria and the DSM-IV criteria after an interview using the Schedule for Affective Disorders and Schizophrenia. Executive dysfunction and memory were assessed with the Dementia Rating Scale, disability and social support were rated with the Philadelphia Multiphasic Instrument, and medical burden was assessed with the Cumulative Illness Rating Scale.

Results: Abnormal initiation and perseveration scores, but not memory impairment, were associated with relapse and recurrence of geriatric depression and with fluctuations of depressive symptoms in the whole group and in subjects who never met criteria for relapse or recurrence during the follow-up period. Memory impairment, disability, medical burden, social support, and history of previous episodes did not significantly influence the outcome of depression in this sample.

Conclusions: Executive dysfunction was found to be associated with relapse and recurrence of geriatric major depression and with residual depressive symptoms. These observations, if confirmed, will aid clinicians in identifying patients in need of vigilant follow-up. The findings of this study provide the rationale for investigation of the role of specific prefrontal pathways in predisposing or perpetuating depressive syndromes or symptoms in elderly patients.

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EXECUTIVE dysfunction, including disturbances in planning, sequencing, organizing, and abstracting, has been reported in late-life depression. Disorders of the basal ganglia and their prefrontal projections are often complicated by depression and result in executive dysfunction. Consistent with clinical observations, white matter hyperintensities have been reported in geriatric depression and mainly occur in subcortical structures and their frontal projections. Ischemic lesions of the caudate head and the left frontal pole often lead to depression. Reduced basal ganglia volumes and changes in the activity of the caudate nucleus and the frontal regions have also been observed in depression. The basal ganglia, the prefrontal areas, the amygdala, and some paralimbic regions seem to be abnormally activated in young persons with depression. Hypometabolism of the rostral anterior cingulate was reported in treatment-resistant depression, while cingulate hypermetabolism was associated with favorable response; integrity of the anterior cingulate is required for some executive functions. White matter hyperintensities were found to predict chronicity of geriatric depression and to be correlated with executive dysfunction. Finally, white matter hyperintensities were associated with low quantitative electroencephalographic coherence, a measure of cerebral connectivity. Low coherence was shown to predict chronicity of late-life depression.

Unlike executive dysfunction, memory impairment does not seem to influence the response to antidepressant treatment. In 2 samples of elderly subjects, memory impairment was not associated with change in depressive symptoms over time.

Besides chronicity, adverse consequences of depression include relapse occurring within 4 to 6 months from remission, recurrence occurring after a well interval of 4 to 6 months or longer, and subsyndromal depressive symptoms.
SUBJECTS AND METHODS
SUBJECTS

The subjects were consecutively recruited elderly psychiatric patients aged 65 years and older. They had achieved remission from major depression after treatment with the antidepressant nortriptyline at dosages resulting in plasma levels ranging from 60 to 150 ng/mL. At entry, the subjects had met Research Diagnostic Criteria (RDC)31 and DSM-IV criteria32 for unipolar major depression without psychotic features, had a score of 19 or greater on the 24-item Hamilton Depression Rating Scale (HDRS),33 and a score of 1 (absent) on the Delusions and Hallucinations items of the Schedule for Affective Disorders and Schizophrenia—LifETIME Version (SADS-L).34 The subjects were considered in remission if they no longer met RDC criteria for depression and had an HDRS score of 10 or lower and a Cornell Scale35 score of 6 or lower for 3 consecutive weeks. Cornell Scale scores of 6 and lower discriminate depressed from nondepressed elderly patients.34 Depressed patients were excluded if they had (1) history of other psychiatric disorders (except personality disorders) prior to their depression; (2) severe or acute medical illness (eg, metastatic cancer, brain tumors, decompensated cardiac, hepatic, or renal failure, or myocardial infarction or stroke within the 3 months preceding the study); (3) neurological disorders (eg, delirium, Parkinson disease, or multiple sclerosis); (4) conditions and drugs that may cause depression (endocrinopathies other than diabetes, lymphoma, or pancreatic cancer, or the use of steroids, β-blockers, α-methyl-dopa, clonidine, reserpine, tamoxifen, or cimetidine); or (5) Mini-Mental State Examination score of less than 17. Therefore, the subjects were nonindolent depressed elderly patients with a wide range of cognitive impairment.

To increase protocol adherence, only subjects residing within a 43-minute drive from the hospital were selected. All subjects were required to have informants who had knowledge of the subject’s history and enough contact so that they could observe changes within a week. Subjects and informants provided written informed consent.

MEASURES

The SADS-L and parts of the Structured Clinical Interview for DSM-IV—Patient Version36 were initially administered when the subjects were symptomatic. Depressive symptoms were assessed using the 24-item HDRS. The HDRS was administered again after 6, 9, and 12 weeks of antidepressant nortriptyline treatment. The last nortriptyline plasma levels of subjects who relapsed were statistically distinguishable from those who remained well (F5,56 = 1.11, P = .28). Post hoc analysis using univariate Cox proportional hazard models showed that the number of previous depressive episodes, medical comorbidity (CIRS-G), disability (MAI Instrumental Activities of Daily Living [IADL] index and MAI Mobility index), and poor social support (MAI index) were not significantly associated with relapse.

RESULTS

A total of 100 subjects received open acute nortriptyline treatment targeting nortriptyline plasma levels between 80 and 120 ng/mL. Of these, 5 dropped out of the study, 7 failed to tolerate nortriptyline, 28 did not achieve remission, 2 died during the acute phase. Therefore, 38 depressed elderly subjects met criteria for remission and entered the continuation phase; 4 of these subjects participated in an acute treatment study as described earlier.19 Of the 58 subjects, 1 was unavailable for follow-up; the remaining 57 subjects completed the continuation phase. The clinical characteristics of these subjects suggest that when symptomatic they had moderate to severe depression, and a wide range of cognitive impairment, medical comorbidity, disability, and social support (Table).
of orientation, verbal recall, verbal recognition, visual matching, and visual memory.

At baseline, medical burden was assessed with the Cumulative Illness Rating Scale, Modified Version for Geriatrics (CIRS-G). The CIRS-G rates chronic medical burden from 14 organ systems. Information was obtained from medical history and physical examination, as well as the available laboratory test results. A total score was computed by adding the subscores of each organ system except the psychiatric/behavioral system. Baseline disability, social support, and physical environment were assessed with the Philadelphia Multilevel Assessment Instrument (MAI).

STUDY PROCEDURES

Once the subjects achieved remission, they received controlled continuation treatment for 16 weeks. Nortriptyline was administered in a single dose at bedtime and plasma levels were obtained monthly. Nortriptyline was chosen because of its known efficacy in long-term treatment of geriatric depression. The dosage was adjusted if nortriptyline plasma levels were not within 60 to 150 ng/mL. Following completion of continuation treatment, the subjects were assigned either to nortriptyline (plasma levels 60-150 ng/mL) or to placebo maintenance treatment for 2 years using random computer numbers, and were followed up under double-blind conditions. In patients randomized to placebo, transition from continuation to maintenance treatment occurred during a period of 10 weeks by reducing the daily dose by 10 mg every 1 to 2 weeks and substituting nortriptyline capsules for an increasing number of inert capsules. The subjects received their medication in 2-week supply kits that permitted dispensation of their daily dosage separately. Throughout the study, the patient visits followed a medication clinic model. No subject received formal psychotherapy.

The subjects were systematically assessed monthly during the continuation phase, every 2 weeks during the transition phase, and every 2 months during the maintenance phase. Assessment consisted of administration of the HDRS and the DRS as well as pill counts. Electrocardiograms and nortriptyline plasma levels were obtained every 2 months and, if needed, the nortriptyline dosage was adjusted to achieve nortriptyline plasma levels of 60 to 150 ng/mL.

STATISTICAL ANALYSES

Survival analysis with proportional risk hazards was used to study the relationship of the hypothesized variables to the occurrence of relapse and recurrence. Mixed-effects models were used to study the relationship of the hypothesized variables to the course of depressive symptoms over time. This analysis treats depressive symptoms and signs (total HDRS score) as a continuous variable and assesses their fluctuation over time. Concordance correlation was used to evaluate the goodness-of-fit of the resultant models and determine the strength of agreement between values estimated by the model and observed values. Two-tailed α levels of significance above .05 were used.

RECURRENT OF GERIATRIC DEPRESSION

Of the 57 subjects who completed the continuation phase, 43 agreed to participate in the maintenance phase (Table) and were randomly assigned either to nortriptyline or placebo. Of the 43 subjects who entered the maintenance phase, 22 continued to receive nortriptyline and 21 were switched to placebo. A total of 15 subjects (35%) had a recurrence during the maintenance phase. Subjects treated with placebo had a higher recurrence rate (52% [n = 11]) than subjects who were maintained with nortriptyline (18% [n = 4]).

To test the hypothesis that IP and not memory impairment predicts recurrence of depression, a Cox proportional hazard model was constructed consisting of the DRS subscores of IP and memory as well as age and treatment assignment. The model was associated with risk for recurrence (likelihood ratio test = 12.9, df = 4, P < .02). However, only IP (risk ratio = 0.83, 95% CI = 0.69-0.99, z = -2.08, P < .04) and treatment assignment (risk ratio = 7.25, 95% CI = 1.97-26.66, z = -2.98, P < .004) were significant predictors (Figure 1), while memory (risk ratio = 1.22, 95% CI = 0.93-1.61, z = 1.44, P > .15) and age (odds ratio = 1.07, 95% CI = 0.99-1.15, z = 1.71, P < .09) did not reach significance. Recurrence could not be attributed to differences in the intensity of nortriptyline.
The last nortriptyline plasma levels of subjects who had a recurrence were statistically indistinguishable from those who remained well \((t_{13} = 0.43, P = .68)\). Post hoc analysis using univariate Cox proportional hazard models showed that the number of previous depressive episodes, medical comorbidity (CIRS-G), disability (MAI Mobility index), and poor social support (MAI index) were not significantly associated with recurrence of depression. The IADL index correlated with IP scores \((r = 0.53)\), but IADL itself was not associated with recurrence.

The relationship of IP and memory to depressive symptoms (total HDRS score) occurring during the maintenance phase was studied using mixed-effects models. First, all patients who received nortriptyline or placebo maintenance therapy were included. A model consisting of IP, memory, group assignment (nortriptyline vs placebo), age, time, and time \(^2\) group assignment was found to have high concordance correlation \((r_c = 0.62)\) with the course of depressive symptoms. However, IP \((F = 6.79, P < .001)\), age \((F = 19.76, P < .001)\), and time \(\times\) recurrence \((F = 19.25, P < .001)\) were the only significant predictors of the course of depressive symptoms.

Subsequent analysis focused on the subjects who did not have a recurrence during the follow-up period. A model consisting of IP, memory, group assignment (nortriptyline vs placebo), age, time, and time \(\times\) group assignment was found to have high concordance correlation \((r_c = 0.62)\) with the course of depressive symptoms. However, IP \((F = 6.79, P < .009)\), age \((F = 17.26, P < .001)\), and memory \((F = -5.98, P < .02)\) were the only variables significantly associated with depressive symptoms. Unlike IP, better memory performance was associated with higher HDRS scores.

The principal finding of this study is that abnormal IP score, age, time, and time \(\times\) group assignment was found to have high concordance correlation \((r_c = 0.62)\) with the course of depressive symptoms. However, IP \((F = 6.79, P < .009)\), age \((F = 17.26, P < .001)\), and memory \((F = -5.98, P < .02)\) were the only variables significantly associated with depressive symptoms. Unlike IP, better memory performance was associated with higher HDRS scores.

**Figure 1.** Cox proportional hazard analysis of recovered depressed elderly patients who underwent continuation treatment with nortriptyline (NT) \((n = 57)\) and subjects who received maintenance treatment with either NT or placebo (C) \((n = 43)\). Fitted survival curves of subjects with low and high initiation and perseveration (IP) scores are shown. The cutoff for low IP was the proportion of subjects who relapsed or had a recurrence: 12% for continuation and 35% for maintenance treatment.
sion. Together, these findings suggest that executive dysfunction constitutes a cognitive dimension associated with poor outcomes of geriatric depression.

Memory impairment did not have a significant relationship to relapse or recurrence. Memory scores were not associated with subsyndromal depressive symptoms during the continuation phase and had an inverse relationship with the course of depressive symptoms during the maintenance phase. These observations suggest that the relationship of executive dysfunction to relapse, recurrence, and subsyndromal depressive symptoms and signs is rather specific.

A potential explanation is that pathway disruption underlying executive dysfunction confers increases the propensity of geriatric depression toward chronicity and recurrence. This conceptualization allows that clinical (such as history of recurrences) and psychosocial factors (such as poor social support) may modify the effect of this vulnerability, although no such effects were observed in this sample.

Executive dysfunction may result from disruption of the cortical-striato-pallido-thalamo-cortical (CSPTC) pathways. Five CSPTC pathways have been described. Each pathway includes a direct circuit with a net excitatory input to the cortex and an indirect circuit with a net inhibitory input. It has been proposed that imbalance favoring the inhibitory circuit of specific CSPTC pathways may contribute to depression. The CSPTC pathways’ function is modulated by the raphe nuclei, locus ceruleus, and ventral tegmentum. Dysfunction of specific pathways can occur through vascular and degenerative processes by disrupting them directly or by damaging their connections to monoaminergic nuclei.

Beyond elucidating the pathophysiology of the course of geriatric depression, our findings offer a rationale for novel psychopharmacological hypotheses. The main neurotransmitters modulating the CSTPC pathways are dopamine, acetylcholine, and enkephalin. Therefore, studies need to investigate whether drugs influencing these neurotransmitters can prevent relapses and recurrences in elderly patients with executive dysfunction.

On a clinical level, the association of executive dysfunction to relapse and recurrence may have implications for patient care. Depressed elderly patients with executive dysfunction may require frequent follow-up assessments, so that additional interventions can be instituted soon after the first depressive symptoms become evident. Education of patients and families may increase clinicians’ ability to identify relapse or recurrence of depression early. Rehabilitative techniques may be used in elderly patients with remitted depression to remedy disturbances in planning, sequencing, and organizing their activities and increase their functional ability and quality of life. However, research needs to examine whether remedying disability resulting from executive dysfunction prevents relapses or recurrences, since the affective vulnerability associated with executive dysfunction may not be mediated by disability, as shown in this sample.

A limitation of this study is the rather small number of subjects who participated in the placebo-controlled nortriptyline maintenance treatment phase. Moreover, these findings cannot be generalized to treatment with selective serotonin reuptake inhibitors, the most frequently used drugs in geriatric depression. Another limitation is the use of a brief neuropsychological instrument that was designed primarily for use with dementia patients and tests some but not all executive functions. However, the DRS subscales of IP and memory used by this study seem to discriminate subcortical dementias from Alzheimer disease, a predominantly cortical dementia. Autopsy studies have shown that patients with the subcortical dementing disorders Huntington disease and supranuclear palsy perform significantly worse than patients with Alzheimer disease on the IP subscale but better on the memory subscale of the DRS. These measures correctly classified 80% of patients with Alzheimer disease and 90% of patients with Huntington disease. Similarly, high impairment in the IP subscale of the DRS and low impairment in the memory subscale characterized patients with Parkinson disease and distinguished them from those with Alzheimer disease. Moreover, functional imaging studies suggest that several functions tested by the IP subscale require integrity of prefrontal circuitry. Performance of a verbal fluency task increases left dorsolateral prefrontal activity. Learning a new motor sequence results in activation of the dorsal prefrontal cortex and the anterior cingulate. Nonetheless, replication of our study with a more extensive neuropsychological battery is necessary.

In conclusion, this study observed that executive dysfunction constitutes a risk factor for relapse and recurrence of geriatric depression and predicts the course of depressive symptoms even in patients who do not develop a new depressive episode. The clinical value of this observation is that patients with executive impairment should be targeted for close follow-up and should be considered for rehabilitative treatment and family counseling that may reduce their disability and family burden. The heuristic value of this finding is that it provides the basis for an empirical inquiry of the pathophysiology of relapse and recurrence. Neuropsychological and functional neuroimaging techniques may be used to describe the role of specific CSPTC pathways in modifying the course of geriatric depression. Finally, drugs influencing neurotransmission of dopamine, acetylcholine, and

![Figure 2. Observed and estimated depressive symptoms (total Hamilton Depression Rating Scale score) in nonrelapsed patients (n = 47) with high (>30) and low (≤30) initiation and perseveration (IP) scores on the Mattis Dementia Rating Scale.](image-url)
enkephalin may be studied for their ability to prevent relapse and recurrence of depression in elderly patients with executive dysfunction.

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