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Depressive symptoms and independence in BADL and IADL

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Abstract—*Purpose*. This study examined the relationship between depressive symptoms and time courses in achieving independence in basic activities of daily living (BADL) and instrumental activities of daily living (IADL). *Methods*. At baseline, 1, 3, and 6 months after stroke, 459 stroke patients were prospectively assessed. We used the Geriatric Depression Scale to determine depressive status. Outcomes were times to achieve independence in BADL (Barthel ≥95) and independence in at least three IADL. We used the Kaplan-Meier method and time-dependent Cox proportional hazards regression to examine the relationship between depression and stroke recovery. *Results*. Depressed patients were 0.3 times less likely than nondepressed patients to achieve BADL of ≥95 and 0.4 times less likely to be independent in three or more IADL. The cumulative percentages for the nondepressed patients to achieve a BADL of ≥95 at 1, 3, and 6 months after stroke were 47%, 63%, and 72%, and for the depressed patients, they were 19%, 34%, and 52%, respectively. Similarly, the cumulative percentages for nondepressed patients to achieve complete independence in three or more IADL at 1, 3, and 6 months after stroke were 56%, 72%, and 85%, and for the depressed patients, they were 32%, 47%, and 72%, respectively. Depressed patients had poorer recovery patterns and took longer to achieve the outcomes. *Conclusion*. Stroke patients with depressive symptoms progressed slower in achieving independence of BADL and IADL compared to patients without depressive symptoms.

Key words: *ADL, BADL, basic and instrumental activities of daily living recovery, depressive symptoms, IADL, stroke.*

INTRODUCTION

Depressive symptoms are common following stroke. The reported prevalence of depression ranged from 20 to 65 percent [1–8]. Yet, investigators reported that many individuals with poststroke depression are not treated [1–4]. This may be because poststroke depression frequently is not recognized or treated by primary care physicians or neurologists, since these physicians mostly focus on neurological and physical functions. Previous cross-sectional studies and a more recent cross-sectional study of stroke patients enrolled in the Stroke Data Bank have demonstrated that greater functional impairment was associated with higher depression scores [3,4,7,8–12]. In addition, poststroke depression also adversely affects recovery, prolongs length of

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hospital stays, and is associated with increased risk of stroke mortality [3,5–9,13,14]. Most previous studies have been cross-sectional and have recruited stroke patients from rehabilitation hospitals [3,4,7,8–12]. Studies with cross-sectional design were able to establish a lower functional status in depressed than in nondepressed patients but were unable to examine the time course of recovery after stroke. Robinson et al. prospectively assessed 61 patients, a subcohort of the Stroke Data Bank, for their 3- and 6-month functional status in patients with and without depression [7]. A significant correlation between 3- and 6-month poststroke functional impairment and baseline in-hospital severity of depression was observed. This prospective study however only included 61 patients who were all from a medical center. Previous prospective studies, including this one, have established less improvement in stroke patients with depression but have not demonstrated a time course of recovery, or more specifically a time course of achieving a Barthel Index of $\geq$95, a commonly used outcome in therapeutic stroke trials.

The purpose of this large prospective cohort of stroke patients recruited from both acute care and rehabilitation hospitals in the community was (1) to assess prospectively prevalence of depressive symptoms at 1, 3, and 6 months after stroke and (2) to examine the time course to achieve independence in basic activities of daily living (BADL) and instrumental activities of daily living (IADL) in patients with and without depressive symptoms.

METHODS

Of the patients who participated in the Kansas City Stroke Study, 459 were included in the analysis. Case ascertainment for the Kansas City Stroke Study started in August 1995 and ended in September 1998. The eligible study participants were systematically recruited from 12 participating hospitals in the Greater Kansas City area. We identified eligible stroke patients by (1) a review of daily admission records; (2) referrals from physicians, clinical nurse specialists, or therapists on medical, neurology, and rehabilitation units; and (3) review of discharge codes. This study was first reviewed and approved by the University of Kansas Medical Center Institutional Review Board. A physician collaborator was identified for each of the 12 institutions and that physician presented the Kansas City Stroke Study to their facilities' Institutional Review Board (IRB). The study was launched after all 12 hospitals' IRB approvals were received. Patients were enrolled after giving informed consent to participate.

To be accepted into this study, the subject had to have a confirmed eligible stroke as defined by World Health Organization (WHO) criteria. A stroke was defined according to the WHO criteria as "a rapid onset and of vascular origin reflecting a focal disturbance of cerebral function, excluding isolated impairments of higher function and persisting longer than 24 hours" [15]. The stroke was confirmed by clinical assessment and/or by a computed tomography/magnetic resonance imaging (CT/MRI) scan. Trained nurses and/or physical therapists reviewed medical records and interviewed both patients and physicians to determine whether the patient was eligible and consented for enrollment. Subjects were excluded if they—

- Were less than 18 years of age.
- Were stroke onset greater than 14 days.
- Had a stroke because of subarachnoid hemorrhage.
- Had hepatic failure.
- Had renal failure.
- Had New York Heart Association (NYHA) III/IV heart failure (i.e., patients with cardiac disease resulting in inability or marked limitation to perform any physical activity without discomfort).
- Were not expected to live 6 months.
- Lived in a nursing home prior to stroke.
- Were unable to handle own affairs before stroke.
- Were lethargic, obtunded, or comatose.
- Lived more than 70 miles from the participating hospital. Informed consents were obtained from all participants and/or proxies.

Using a variety of standardized assessments, a study nurse and/or physical therapist evaluated the patients at enrollment and at 1-, 3-, and 6-month follow-ups poststroke at home or at a chronic-care facility. Each study nurse and/or physical therapist received at least 2 weeks of training in the administration of the measures. All study nurses and physical therapists received certification in administration of National Institutes of Health (NIH) Stroke Scale (NIHSS) [16]. Assessments included in this study are baseline demographics, stroke characteristics, and stroke severity measured with the use of the Orpington Prognostic Scale [17,18], Barthel Index [19],

Geriatric Depression Scale (GDS) [20], Lawton IADL [21], and SF-36 Physical Functioning Index (PFI) [22].

The Orpington Prognostic Scale was used to measure stroke severity at baseline. This scale includes measures of motor deficit in arm, proprioception, balance, and cognition. The score of the Orpington Prognostic Scale ranges from 1.6 to 6.8, with 1.6 being the best score and 6.8 being the worst score. Strokes can be further categorized as mild (score < 3.2), moderate (3.2 ≤ score ≤ 5.2), or major (score > 5.2). Details on administration of the Orpington Prognostic Scale has been described elsewhere [18]. We used the Barthel Index, which is a weighted instrument that includes 10 items in assessing self-care (feeding, bathing, washing face, brushing teeth, toileting, dressing, and bowel and bladder care) and mobility (transfer, ambulating, and stair climbing), to measure BADL. The BADL scores range from 0 to 100, with 100 being minimum or no disability (or independence but not necessarily normal status) [3,19].

We used the SF-36 PFI scores ranging from 0 to 100, with 100 being fully functioning, to measure self-reported physical function prior to stroke. The Lawton IADL assesses nine IADL, including preparing own meals, using the telephone, shopping for groceries, getting to places out of walking distance, doing own housework, doing handyman work, washing clothes, managing own money, and taking own medications. Each activity is reported as being done without help, with some help, or not at all.

The short GDS with 15 items was used to assess symptoms of depression. The short GDS is a rating scale that is used to assess domains of (1) a sad mood and pessimistic outlook, (2) mental and physical energy, (3) a positive or happy mood, (4) agitation or restlessness, and (5) social withdrawal [23]. The GDS-15 rating scale that ranges from 0 to 15 points, with a score of 6 points or higher being considered as depressive, has been shown to be a good screening instrument for depression with its high sensitivity and specificity [24,25]. Furthermore, the GDS has been tested in stroke patients and found to have satisfactory sensitivity and specificity with a cutoff point of six or higher being depressive [27–28].

Finally, we used the Charlson comorbidity index to characterize degree of comorbidity of each patient [29]. This comorbidity index assigns weights for each condition that a patient has. The total weighted score ranges from 0 (no medical condition) to 37 points, with 1 point each from myocardial infarct, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease, ulcer disease, mild liver disease, and diabetes; 2 points each from hemiplegia, moderate or severe renal disease, diabetes with end organ damage, any tumor, leukemia, and lymphoma; 3 points from moderate or severe liver disease; and 6 points each from metastatic solid tumor and Acquired Immune Deficiency Syndrome (AIDS).

We used descriptive statistics to show demographics, prior functional status, stroke characteristics, severity of impairment caused by stroke, as well as disability measured by the Barthel Index. Proportions of depressed patients at baseline and at 1, 3, and 6 months after stroke were reported. A Chi-square test or student t-test was used to test for statistical significance when appropriate.

The major outcomes of this study were the time to achieve a BADL of ≥95 and the time to achieve independence in three or more IADL. We chose a BADL of ≥95 (defined as minimal or no disability) to define a favorable outcome in accordance with the National Institutes of Neurological Disorders and Stroke (NINDS) and European Cooperative Acute Stroke Study (ECASS) II trials [30,31]. Kaplan Meier survival curves were used to demonstrate cumulative proportions of depressed and nondepressed patients achieving a BADL of ≥95. Since the study was prospective in nature, the depressive status of any given patient can change over time. We used the time-dependent Cox proportional hazards regression [32–33] (which took into account subjects changing depressive status over time) to examine the relationship between depressive status and the time to achieve a BADL of ≥95, after considering age, self-reported prior physical function, stroke severity, and comorbidities composite score. In this time-dependent Cox regression modeling, depression status was updated before each "event time" (namely, achieving a Barthel Index of ≥95). By doing so, the subjects who had missing information on depression status at baseline were included in the analysis later during follow-ups if they were either confirmed or disconfirmed as depressed. We also analyzed time to achieve independence in three or more IADL as an outcome using the time-dependent Cox proportional hazards regression. A minimum of three activities were chosen based on focus groups and previous studies that showed three activities (for example, meal preparation, administration of medication, and mobility outside the home) that were basic and relevant to both genders [34,35].

RESULTS

Of the patients enrolled in the Kansas City Stroke Study, 459 had a mean age of 70 ± 11.4 years, 245 were female (53.4 percent), 366 were Caucasian (80 percent), and 78 were African American (17 percent). Before the stroke, all the subjects were independent in ADL. A self-reported assessment of their higher levels of physical function 1 week before stroke as measured by the SF-36 physical function questions was 70 ± 28.0. Of the 459 strokes, 430 (93.7 percent) were cerebral infarction and 29 (6.3 percent) were intracerebral hemorrhages. These strokes were further categorized as mild in 179 (39 percent), moderate in 229 (50 percent), and major in 51 cases (11 percent). Before the 6-month assessment, 32 patients died, 37 subjects refused to be followed, and 13 patients moved away.

Of the 459 patients, 131 (29 percent) and 267 (58 percent) were classified as depressed and nondepressed by GDS at baseline. The remaining 61 patients (13 percent) were either too ill or aphasic and were unable to complete the GDS assessment. **Table 1** shows stroke characteristics and demographics, prior to stroke physical functioning, in the three groups (depressed, nondepressed, and not assessed). Patients who were depressed or unable to complete the GDS assessment at baseline were more likely to be major or moderate stroke patients than mild stroke patients (**Table 1**). Consequently, patients who were depressed or not assessed for GDS status were more disabled than those who were not depressed. The former two groups of patients also had

Table 1.
Characteristics by depression status at baseline.

Characteristics	Depressed (n = 131)	Normal (n = 267)	Unknown (n = 61)	*p* Value
Mean Age ± SD	69.3 ± 12.1	69.1 ± 10.5	74.9 ± 12.6	0.0015
Prior Physical Function*	61.9 ± 29.7	73.8 ± 26.5	66.3 ± 27.2	0.0003
Time Since Stroke*	8.4 ± 3.5	8.3 ± 3.7	9.8 ± 3.1	0.0102
Time Since Stroke Onset*	15.8 ± 37.3	17.3 ± 33.7	10.7 ± 27.4	0.0174
	%	%	%	
Gender Male	43.5	49.4	41.0	0.343
Race	—	—	—	0.763
Caucasian	81.7	79.0	78.7	—
African American	13.7	18.4	18.0	—
Hispanic	3.1	1.9	1.6	—
Others	1.5	0.7	1.7	—
Type of Stroke	—	—	—	0.002
Ischemic	94.7	95.5	83.6	—
ICH	5.3	4.5	16.4	—
Baseline Stroke Severity	—	—	—	<0.001
Mild	27.5	52.4	5.0	—
Moderate	65.6	44.6	39.3	—
Major	6.9	3.0	55.7	—
Baseline NIH Stroke Scale	6.9 ± 4.6	5.2 ± 3.7	15.0 ± 7.7	<0.0001
Baseline Barthel	45.2 ± 27.3	60.5 ± 26.8	21.3 ± 25.9	<0.0001
Baseline Charlson Comorbidity Index	3.0 ± 1.6	2.6 ± 1.5	3.2 ± 1.3	0.0028

*Some missing values exist.
ICH = intracerebral hemorrhage
SD = standard deviation
NIH = National Institutes of Health

lower physical functioning before stroke onset and a higher weighted Charlson comorbidity index (**Table 1**). The most commonly reported comorbidities were diabetes (35 percent), hemiplegia (24 percent), and myocardial infarct (23 percent) for depressed patients; hemiplegia (43 percent), diabetes (25 percent), and myocardial infarct (20 percent) for those unable to complete the GDS assessment at baseline; and diabetes (33 percent), hemiplegia (18 percent), and myocardial infarct (17 percent) for non-depressed patients. Age, sex, race, and stroke type were similar among those who were depressed and not depressed at the baseline. Patients who were unable to complete the GDS assessment were older.

Of the patients whose depressive status was known, the proportions that were considered as depressed were 33 percent at baseline, 35 percent at 1 month, 34 percent at 3 months, and 30 percent at 6 months after stroke. Of the 61 patients who were unable to complete the GDS assessment at the baseline, 19 subjects (31 percent) were classified as depressed during follow-up visits at 1, 3, and 6 months. Of the 267 subjects who were not depressed at baseline, 83 of them (31 percent) were subsequently classified as depressed during follow-up visits. On the other hand, 98 of the 131 subjects (75 percent) who were considered as depressed at baseline continued to be depressed. Our analysis also showed that the proportion of depressed patients was significantly higher in major stroke patients than the proportion in moderate or mild stroke patients ($p < 0.01$, **Figure 1**).

Figures 2 and **3**, respectively, show the Kaplan-Meier estimates of achieving BADL ≥ 95 and being independent in three or more IADL by depression status at baseline. The analysis from the Cox proportional hazards regression showed that depressed patients were less likely than non-depressed patients to achieve BADL of ≥ 95 (**Table 2**: risk ratio (RR) = 0.3, 95% confidence interval (CI) = 0.23–0.50). Similarly, depressed patients were 0.4 times less likely to be independent in three or more IADL activities (**Table 3**: 95% CI = 0.30–0.62). The risk ratios were calculated after adjusting for physical functioning before

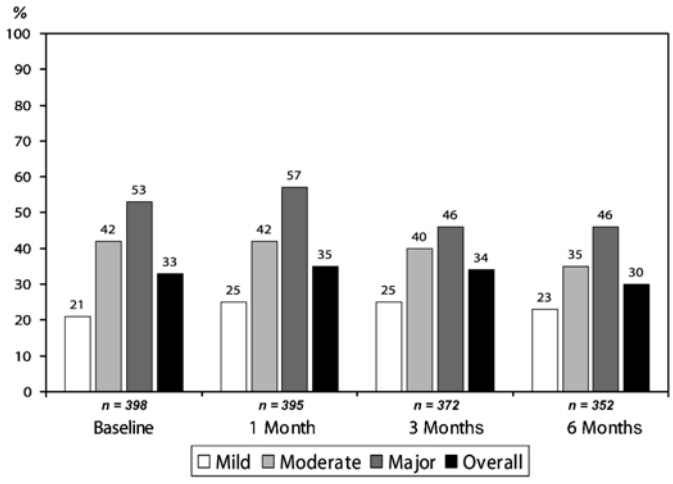

Figure 1.
Depression after stroke.

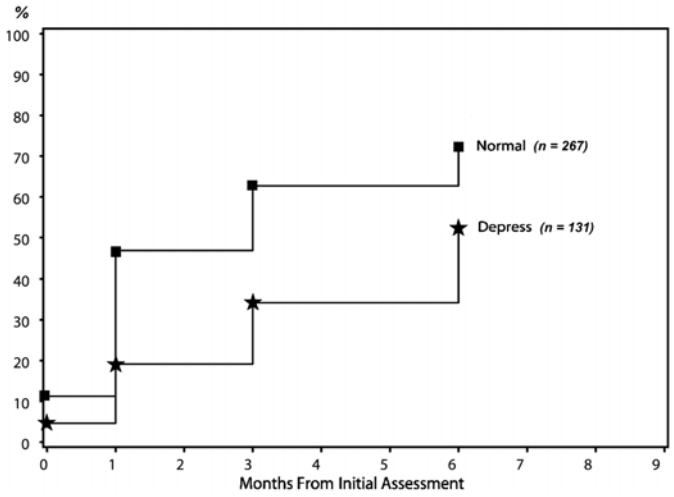

Figure 2.
Kaplan-Meier estimates of cumulative probability of achieving BADL of ≥95.

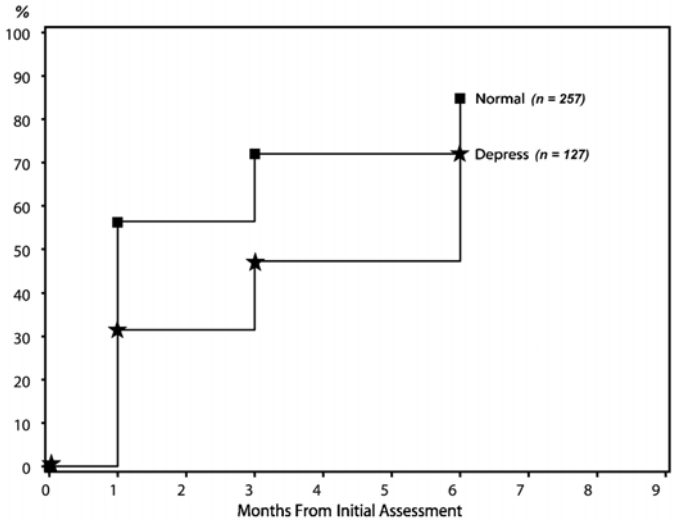

Figure 3.
Kaplan-Meier estimates of cumulative probability of achieving three or more IADL.

stroke, stroke severity, and age. The cumulative percentages of patients achieved a BADL ≥ 95 at 1, 3, and 6 months after stroke were 47, 63, and 72 percent for nondepressed and 19, 34, and 52 percent for the depressed patients, respectively. Similarly, the cumulative percentages for patients to achieve complete independence in three or more IADL at 1, 3, and 6 months after stroke were 56, 72, and 85 percent for nondepressed and 32, 47, and 72 percent for the depressed patients. Depressed patients had poorer recovery patterns and took longer to achieve the outcomes.

DISCUSSION

The results of this study demonstrate that depression is common after stroke and does not change much over the first 6 months poststroke. Thirty-one percent of the patients (83 out of 267) who were not depressed at baseline became depressed at various times during their follow-up assessments. Nineteen of the sixty-one patients who were aphasic or too ill to be assessed for depression status at baseline also became depressed during follow-up visits. Patients with moderate or severe stroke were more likely to be depressed at baseline. Depression among patients with moderate or severe stroke was more likely to persist over time than depression among patients with mild stroke.

Our study is consistent with previous studies [3,4,7,8–12,25,36]; that is, depressed patients were more disabled than nondepressed patients were. The extent of stroke recovery associated with depression has been widely studied; however, the time course of stroke recovery has not been examined. In this study, we used fixed poststroke time points rather than the time around hospitalization or rehabilitation to assess outcomes. Compared to other studies, we assessed a greater range of outcomes (from basic to higher levels of functioning) using various validated instruments (BADL and IADL). Our study showed that most stroke patients have demonstrated recovery, but achieving independence in BADL and IADL has been further delayed by the presence of depressive symptoms. At 1 month after stroke, 47 percent of the nondepressed patients achieved a BADL of ≥95, yet only 19 percent of the depressed patients achieved a BADL of ≥95 (**Figure 2**). By 6 months after stroke, 72 percent of the nondepressed achieved a BADL of ≥95 compared to only 52 percent of the depressed patients who have achieved this level of independence (**Figure 2**). Similarly, 85 percent of the nondepressed patients achieved complete independence in three or more IADL compared to a 72 percent of the depressed group (**Figure 3**). Patients who were depressed were less likely to achieve a BADL of ≥95 or be able to perform three or more IADL compared to those not depressed. Furthermore, depressed patients took longer to achieve the same level of independence, if indeed they recovered. This information can further help determine the appropriate timing of rehabilitation efforts.

Patients who had depressive symptoms after stroke also had a lower physical functioning before their stroke. After physical function before stroke was considered, achieving independence in BADL and IADL remained slower in the depressed group than in the nondepressed group. Prior physical functioning has been found to influence recovery outcomes after stroke [37]. This factor should be considered before any conclusion in ADL and IADL recovery is made in the study of depression after stroke.

Our study was prospective in design, which allowed us to characterize the prevalence of depression from the onset of stroke to 6 months after stroke in a cohort of

Table 2.
Risk ratio associated with depression status in achieving BADL independence of ≥95.

Factor	Risk Ratio	95% CI	*p* Value
Age (per yr)	0.97	0.95–0.98	0.0005*
Orpington Score	0.3	0.26–0.40	<0.0001*
Prior Physical Function (per unit charge)	1.014	1.01–1.02	<0.0001*
Depressive	0.3	0.23–0.50	<0.0001

*For directional test.
Note: Charlson comorbidity index score was not statistically significant. Twenty-four cases were excluded because of missing depressive status over entire 6-month follow-up.

Table 3.
Risk ratio associated with depression status in achieving independence of three or more IADL.

Factor	Risk Ratio	95% CI	*p* Value
Age	0.97	0.95–0.98	0.0002*
Orpington Score	0.4	0.31–0.45	<0.0001*
Prior Physical Function	1.014	1.01–1.02	<0.0001*
Depressive	0.4	0.30–0.62	<0.0001

*For directional test.
Note: Charlson comorbidity index score was not statistically significant. Nineteen cases were excluded from the analysis because of missing depressive status over entire 6-month follow-up.

community stroke patients. All patients were recruited from both acute care and rehabilitation hospitals and evaluated by the same interviewers who used the standardized questionnaire for assessing the patients' depression status at four fixed time points until 6 months poststroke. This further enabled us to examine the time course of stroke recovery associated with depression status after stroke and to generalize our findings to stroke patients in the nonrehabilitation setting.

Several methodological concerns might affect the interpretation of our data. The first is the issue of sample bias. Patients with severe stroke and/or aphasia were not assessed for their depressive status at baseline. Subsequently, our findings may not be generalizable to aphasic and major stroke patients. Another potential methodological concern is heterogeneity of stroke groups. Factors such as treatment of depression and the presence of cognitive impairment that may also affect stroke recovery were not examined in our study [38]. Finally, our study was not able to determine if patients were depressed before stroke. However, this should not affect studying the association between depressive symptoms and stroke recovery. The short-form GDS is a 15-item questionnaire to which subjects responded by indicating yes or no to questions about depressive symptoms [20]. This rating scale is one of the most widely used instruments for the screening of depression in later life [39]. It has been shown to be able to detect the presence of a major depressive episode among older adults [23–27,35–40] according to current diagnostic criteria for major depression as defined by both International Classification of Diseases (ICD)-10 and Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV [40]. It should also be recognized that the GDS-15 is an effective way of identifying subjects with significant depressive symptoms, but it is not a diagnostic tool.

In summary, depressive symptoms have been shown to be highly prevalent throughout the 6 months poststroke. Depressive symptoms are associated with higher levels of disability in BADL and IADL. Time course in achieving independence in BADL and IADL is slower for stroke patients with depression. Most importantly, poststroke symptoms of depression need to be recognized and appropriately treated to enhance functional outcomes.

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