Properties of the Early Symptom Measurement of Post-Stroke Depression: Concurrent Criterion Validity and Cutoff Scores

Jufang Li1,6 • Linda Denise OAKLEY2,6 • Roger L. BROWN3 • Yun Li4 • Yong LUO5*

ABSTRACT

Background: Early-stage post-stroke depression (PSD) increases the risk of stroke-related disability and mortality in the first year of recovery. Presently available screening measures were developed to assess major depression, and none used a PSD screening criterion that was systematically developed and tested in populations of patients with acute stroke.

Purpose: The purpose of this study was to evaluate the concurrent criterion validity and cutoff scoring of the Early Symptom Measurement of Post-Stroke Depression (ESM-PSD) instrument in hospitalized patients with acute stroke.

Methods: Purposive recruitment of newly admitted patients yielded a qualified sample of 139 nonaphasic participants who were 7–30 days post mild-to-moderate stroke confirmed by computed tomography and magnetic resonance images. Participants responded to the ESM-PSD and Hamilton Rating Scale for Depression-24 (HAM-D-24).

Results: The mean number of post-stroke days was 11.99 (SD = 7.68). Cronbach’s alpha estimates of internal consistency were ESM-PSD = .90 and HAM-D-24 = .76. ESM-PSD measurement sensitivity and specificity were superior. The following three ESM-PSD cutoff scores, determined by the receiver operating characteristic curve, were used to assess clinically relevant early-symptom levels: no PSD < 14.5, low PSD = 14.5–25.5, moderate PSD = 25.5–45.5, high PSD ≥ 45.5.

Conclusion/Implications for Practice: ESM-PSD cutoff scores show the expected correspondence with mild–moderate–severe HAM-D-24 symptoms, which was evidenced by the high area under the receiver operating characteristic curve. Planned follow-up research will assess the efficacy of using ESM-PSD scores to detect increased risk of major depression onset in patients with acute stroke.

Key Words: post-stroke depression (PSD), concurrent criterion validity, patients with acute stroke, cutoff scores.

Introduction

Early-stage post-stroke depression (PSD) refers to PSD occurring within the first 30 days post-stroke, which is the time period of peak symptom onset (Gao, 2015; Zhang, Zeng, & Liu, 2015). Research has shown that more than one third of hospitalized patients with stroke are likely to develop symptoms of early-stage PSD (Towfighi et al., 2017). With incidence rates ranging from 25% to 79%, PSD following mild-to-moderate stroke is both common and one of the most severe complications in patients with acute stroke (Mitchell et al., 2017; Zahi, Mahir, Azanmasso, Lmidmani, & El Fatimi, 2016). Early symptoms of PSD increase the risk of major depression onset at 6 months post-stroke, the stage of recovery where the risk of disability and death by suicide may reach as high as 70%–90% (Lewin-Richter, Volz, Jobges, & Werheid, 2015). In other words, the morbidity and mortality risks of PSD equal or exceed the morbidity and mortality risks of mild-to-moderate stroke. This is due in large part to the effects of early-stage PSD on prognosis and quality of life outcomes (Bartoli et al., 2013; Koostamongkol, Sindhu, Pinyopasakul, Nilanont, & Redman, 2013; Schulte-Altedorneburg & Bereczki, 2014).

PSD complicates the recovery of speech and motor functions and decreases the ability and desire to participate in rehabilitation, to socialize, and to “rejoin” life (Dwyer Hollender, 2014; Towfighi et al., 2017). Neurobiological findings show that early-stage PSD may increase the 1-year risk of stroke recurrence by as high as 49%, even with treatment with antidepressant medications (Yuan et al., 2012). Moreover, early-stage PSD increases the risk of chronic depression. A retrospective study found that 68.7% of patients diagnosed with chronic PSD also...
had early PSD symptoms (Shi et al., 2016). Also, early-stage PSD at 6 and 12 months has been shown to be associated with stroke-related mortality at 12 and 24 months post-stroke (Lewin-Richter et al., 2015). In recognition of the clinical risks of early-stage PSD, clinicians are now expected to identify and effectively manage early-stage PSD symptoms (Schneider & Schneider, 2012). However, because both outcomes are poorly understood (Robinson & Jorge, 2015), few patients with acute stroke are likely to receive timely and effective assessment and management. The central problem is the lack of screening tools specifically developed to detect symptoms of early-stage PSD in patients with acute stroke.

Background
Several clinical assumptions decrease the probability that any symptoms of PSD are adequately assessed during the first 30 days post-stroke. First, clinicians who are confident in the treatment imperative to prioritize physical symptoms during the acute post-stroke stage are less likely to treat symptoms of depression (Li, 2016). Second, proper mental healthcare services often are not available or accessible to hospital patients. Third, studies show that the prognosis and emotions of patients during the acute stage may be unstable, thereby increasing the probability that any findings from a psychological assessment may not be reliable or stable. Although these observations cannot be dismissed, they incorrectly assume that early symptoms of PSD in the patients with acute stroke are clinically less important and have negligible risk of severe morbidity and mortality. Study findings have shown that assessing early symptoms of PSD when assessing the physical symptoms of mild-to-moderate stroke may decrease the risk of PSD and major depression onset at 6 months.

Most of the related research in the literature are studies of late-onset symptoms of depression in recovering patients with stroke who meet diagnostic criteria for major depression, or major depression is reconceptualized, using lower scores, as a milder form of the illness (Li, Oakley, Li, & Luo, 2018). The aim of these assessments is thus primarily to detect symptoms of major depression or dysthymic depression in patients with a history of stroke. In contrast, this study addresses clinical problems related to assessing, detecting, and managing PSD as a unique condition on the depression spectrum, with early-stage PSD defined as the onset of symptoms and somatic signs in the acute (first 30 days) post-stroke stage (Li et al., 2016). Early-stage patients are more likely to show symptoms of depression with vegetative state and impaired social skills related to psychological dysfunctions (Tateno, Kimura, & Robinson, 2002), whereas major depression is a state of depressed mood characterized by slow thinking and less activity. Time frame, the important distinction between PSD and major depression, complicates the assessment of early-stage PSD (Li, 2016). The 2-week time frame for assessing and diagnosing symptoms of major depression is a better fit with preexisting or prestroke symptoms of depression than early-onset symptoms of PSD within a few days post-stroke (Shi et al., 2015).

The PSD measure in this study was developed (Li et al., 2018), and preliminary psychometric testing was conducted (Li et al., 2016) of a revised version of the Early Symptom Measurement of Post-Stroke Depression (ESM-PSD) using separate samples of hospitalized patients with stroke who were 7–30 days post-stroke. The ESM-PSD, designed for use as an assessment tool, has been shown to have acceptable internal reliability (total Cronbach’s α = .93, domains = .82–.90) and discriminant validity in patients with acute stroke. The specific aim of this study was to use the Hamilton Rating Scale for Depression-24 (HAM-D-24) to evaluate the concurrent criterion validity and scoring of the ESM-PSD in hospitalized patients with acute stroke. Acceptable evidence of ESM-PSD concurrent criterion validity and clinically relevant scoring would allow the testing of the validity and reliability of the ESM-PSD to assess and detect early-stage PSD in hospitalized patients with early-stage stroke and to compare ESM-PSD scores with 3-month, 6-month, and 9-month follow-up assessments of symptoms of major depression.

Methods
Sample
Purposive recruitment methods were used over a period of 6 months from March to August in 2015 to develop a qualified sample of adult patients with stroke newly admitted to a general hospital in southeast China. Eligible male and female patients were 18 years old or older, had a primary admission diagnosis of mild or moderate stroke as confirmed by computed tomography and magnetic resonance images, and were between 7 and 30 days post-stroke at the time of interview. Patients were not eligible if their primary admission diagnosis was severe or critical stroke as confirmed by computed tomography and magnetic resonance images: if they were seriously ill or in need of intensive care; if their current symptoms included severe aphasia, attention impairment, or cognitive impairment; or if either the patient or a close family member has been diagnosed with any form of mental disorder. All eligible patient volunteers (N = 144) were invited to take part in the study. Five appeared too uncomfortable to continue shortly after starting and were withdrawn by a qualified member of the research team. The final analytic sample included 139 patients with early-stage stroke.

Procedures
All of the study procedures were reviewed and approved by the appropriate university institutional review board (Approval No. 2015-14). All of the recruitment and safety protocols were performed by trained members of the research team. Patient eligibility was confirmed by chart review prior to first patient contact. Individual, face-to-face interviews were conducted with the eligible patients, all of whom provided written consent. All of the study measures were read aloud to the participants, who responded by speaking their
answers. Each participant was reassured that he or she could withdraw from the study at any time for any reason without question and that the interviewer could end the interview and withdraw the participant from the study if, at any time, the patient appeared fatigued or uncomfortable.

Measures

Background
Participant background items included age, number of days post-stroke, gender, marital status, live with family members (yes, no), total completed years of education, monthly household income, current employment status, residential district (urban, rural), religious beliefs (yes, no), medical coverage/payments (yes, no), and family member is the primary caregiver post-stroke (yes, no).

Post-stroke depression
The ESM-PSD was developed in a sample of patients with acute stroke (mean = 11.07 days post-stroke; Li et al., 2016). This measure includes 26 items and the following six symptom domains: (a) low (e.g., I feel life is meaningless), (b) dull (e.g., My mind is not as clear as usual), (c) guilt (e.g., I feel I am a burden on my family), (d) emotional (e.g., I get angry more easily than usual), (e) wakefulness (e.g., I need more time than before to fall asleep), and (f) nervous (e.g., I worry excessively about my physical health). Respondents are asked to rate their symptom frequency during the last 7 days on a 5-point scale: 0 = never, 1 = rarely, 2 = sometimes, 3 = often, and 4 = always. All of the responses are summed, and the possible score range is 0–104. The ESM-PSD has acceptable construct validity and internal reliability.

Clinical depression
The HAMD-24 is the most commonly used depression scale worldwide (Aben, Verhey, Lousberg, Lodder, & Honig, 2002). In this study, HAMD-24 was selected as the criterion-related variable for several reasons. First, HAMD-24 has been widely used in validation studies of new measures (Bagby, Ryder, Schuller, & Marshall, 2004). Second, clinical psychiatrists tend to use the 17-item HAMD to assess the treatment of patients in China (Zheng et al., 1988), whereas researchers needing greater specificity use the 24-item HAMD for clinical studies of stroke-related depression (Yue, 2017). Third, healthcare professionals use the 24-item HAMD when assessments of symptom severity must cover all symptom domains: anxiety/somatic, weight loss, cognition, day–night change, psychomotor retardation, sleep disorders, and desperation. Lastly, although the Beck Depression Inventory has been reported by some researchers as more suitable than HAMD-24 for screening depression in patients with stroke (Berg, Lönnqvist, Palomäki, & Kaste, 2009), HAMD-24 has shown higher specificity in the same patient group (Berg et al., 2009). For the above reasons, the HAMD-24 was selected as the criterion-related variable in this study. The HAMD-24 may be used with either a three-item or five-item response scale. In addition, total HAMD-24 scores may be used to define clinically relevant symptom levels: < 8 = no depression, 8–19 = mild depression, 20–34 = moderate depression, and ≥ 35 = severe depression (Pan et al., 2017; Zhu et al., 2015). The HAMD-24 is not sensitive to administrative error and has acceptable interrater reliability and internal reliability (Cronbach’s α = .88–.99, p < .01). The empirical authenticity coefficient, an indicator of assessment accuracy for clinically relevant symptom severity, is .92 (Sun, Li, Yu, & Li, 2017). In this study, the HAMD-24 interrater reliability coefficient is .83. Each participant was administered the HAMD-24 twice by two respective researchers, with the final HAMD-24 score for each participant calculated as the mean of these two scores.

Statistical Analysis
SPSS Statistics Version 23.0 (IBM, Inc., Armonk, NY, USA) was used to perform all of the analyses in this study. To describe the sample, the total frequencies and percentages for all background items were calculated. Means and standard deviations were used to statistically characterize all of the symptom domains in the ESM-PSD and the HAMD-24. Cronbach’s alpha coefficients were used to estimate the internal measurement consistency of all of the symptom domains and total scores. Cutoff scores for the HAMD-24 were accepted as clinically relevant levels of depression symptom severity. The receiver operating characteristic (ROC) curve for the ESM-PSD on the HAMD-24 was used to define clinically relevant cutoff scores for the ESM-PSD. Parabola estimation methods (Simpson) were used to calculate the area under the curve, sensitivity (Se), total score specificity points (Sp), and the Youden index [Se + Sp – 1] (Moon, Jin, Jin, & Lee, 2017). The best cutoff points for the total ESM-PSD score based on the maximum Youden index, sensitivity, and specificity were adopted (Maggino et al., 2019). The discriminative validity of the ESM-PSD scores were explored using three HAMD-24 reference points (8, 24, and 35) to identify the participants with no depression, with mild-to-moderate depression, and with moderate-to-severe depression. One-way analysis of variance (ANOVA) was employed to further confirm the diagnostic ability of the cutoff scores of HAMD-24 and ESM-PSD to distinguish the different levels of depression. The Kappa coefficient is a test of the degree of coincidence between the cutoff scores for the two measures. The Kappa coefficient value ranges from [−1 to 1], with higher values associated with a higher degree of measurement consistency. Kappa coefficients greater than .75 indicate good measurement consistency, whereas those less than .40 indicate poor measurement consistency (Tang, Hu, Zhang, Wu, & He, 2015).
Participants
Background characteristics for the final sample \((N = 139)\) are presented in Table 1. The mean age of the sample was 64.24 years \((SD = 12.44)\), and the mean number of post-stroke days was 11.99 \((SD = 7.68)\). Most participants were male (64.7%), married (85.6%), and living with family (92.8%), and most had completed between 6 and 16 years of education (71.9%). Few rated their monthly household income as high \((n = 20, 14.4\%)\). Less than a quarter were retired (20.1%), most lived in rural districts (66.2%), less than half were religious or held religious beliefs (31.7%), and most (66.9%) had medical coverage that paid approximately 70% of their medical and hospital costs.

Early Symptom Measurement of Post-Stroke Depression and Hamilton Rating Scale for Depression-24 Internal Consistency
The Cronbach’s alpha coefficients for the domains of the ESM-PSD in patients with acute stroke ranged from .78 to .90 (Table 2). These estimates met the preliminary criteria in this study for acceptable measurement reliability \((\geq .70; \text{Houser, 2013; Santos, 1999)}\). Except for the single-item domains, similar evidence was found in this study for the domain internal consistency of the HAMD-24 (Cronbach’s \(\alpha = .76–.79\)). The Cronbach’s alpha for the HAMD-24 domains that failed to reach .70 were as follows: psychomotor retardation (four items) = .26, sleep disorders (three items) = .52, desperation (three items) = .69, weight loss (one item), and day–night change (one item).

TABLE 1. Demographic Characteristics of the Participants \((N = 139)\)

| Variable                        | \(M\)  | \(SD\)  |
|--------------------------------|--------|---------|
| Age (years)                    | 64.24  | 12.44   |
| Average number of days post-stroke | 11.99  | 7.68    |
| Male                           | 90     | 64.7    |
| Married                        | 119    | 85.6    |
| Living with family members     | 129    | 92.8    |
| Educated                       | 100    | 71.9    |
| High monthly income (more than 5,000 RMB)* | 20     | 14.4    |
| Retired                        | 28     | 20.1    |
| Living in rural area           | 92     | 66.2    |
| Having religious beliefs       | 44     | 31.7    |
| Medical payment                | 93     | 66.9    |
| Primary caregivers: family members | 117    | 84.2    |

*Chinese currency.

Early Symptom Measurement of Post-Stroke Depression Concurrent Criterion Validity
Pearson bivariate correlation coefficients (Table 3) estimated concurrent criterion validity by comparing ESM-PSD and HAMD-24 items (Coronado et al., 2016; DeSimone, Harms, Vanhove, & Herian, 2017). Meaningful comparisons are able to be made because the HAMD-24 is a well-established, clinical interview approach that is used to assess depression symptom severity or change in depression symptom severity in clinically populations and is used routinely to test criterion validity in new measures (Kang et al., 2013). The correlation coefficient for total ESM-PSD and HAMD-24 scores was found to be positive and statistically significant \((r = .689, p < .05)\). In addition, the correlation coefficient for ESM-PSD and HAMD-24 domain scores were positive and statistically significant, ranging from .197 to .772 \((p < .05)\). Four ESM-PSD scores (low, wakefulness, nervous, total) correlated positively with six HAMD-24 scores. Two ESM-PSD scores (dull, guilt) positively correlated with all but one HAMD-24 domain (day–night change). One ESM-PSD score (emotional) positively correlated with all but one HAMD-24 domain (retardation).

Post-stroke patients with or without symptoms
An HAMD-24 cutoff score of 8 was used as the reference point to explore which potential ESM-PSD cutoff score is able to best discriminate between post-stroke patients with and without depression. The sensitivity, specificity, Youden index, and ROC curve of the ESM-PSD total scores are presented in Table 4, with an HAMD-24 cutoff score of 8 used as the reference point. An ESM-PSD score of 14.5 corresponds with the maximum Youden index (0.811), with a corresponding sensitivity and specificity of 94.4% and 86.7%, respectively. For this ESM-PSD score, the area under the ROC curve is 0.941 (95% CI [0.893, 0.989]). An ESM-PSD cutoff score of 14.5 was then used to divide the sample of post-stroke patients into two groups. An independent-sample \(t\) test of the mean ESM-PSD scores for both groups showed statistically significant differences, \(t(117.280) = 20.375, p < .001,\) between post-stroke patients with no symptoms of depression \((M = 5.26, SD = 3.91)\) and post-stroke patients with symptoms of depression \((M = 38.94, SD = 15.30)\). These results support that an ESM-PSD cutoff score of 14.5 distinguishes between post-stroke patients with or without early-stage PSD.
Post-stroke patients with mild or moderate symptoms

An HAMD-24 cutoff score of 20 was used as the reference point to explore potential ESM-PSD cutoff scores to discriminate between post-stroke patients with mild symptoms and post-stroke patients with moderate symptoms. The sensitivity, specificity, Youden index, and ROC curve of the ESM-PSD total scores using an HAMD-24 cutoff of 20 are presented in Table 4. An ESM-PSD total score of 25.5 corresponds with the maximum Youden index (0.595), with a corresponding sensitivity and specificity of 92.3% and 67.2%, respectively. For this ESM-PSD score, the area under the ROC curve is 0.858 (95% CI [0.795, 0.921]). Next, we used an ESM-PSD cutoff score of 25.5 to divide the post-stroke patients into two groups. An independent-sample t-test comparison of subgroup means showed statistically significant symptom differences, \( t(137) = 14.251, p < .001 \), between post-stroke patients with mild symptoms (\( M = 14.15, SD = 8.47 \)) and post-stroke patients with moderate symptoms (\( M = 44.29, SD = 13.16 \)). These results support using an ESM-PSD cutoff score of 25.5 to distinguish post-stroke patients with mild depressive symptoms from post-stroke patients with moderate depressive symptoms.

Post-stroke patients with moderate or severe symptoms

An HAMD-24 cutoff score of 35 was used as the reference point to explore ESM-PSD cutoff scores to distinguish post-stroke patients with moderate symptoms from post-stroke patients with severe symptoms. The sensitivity, specificity, Youden index, and ROC curve of the ESM-PSD total scores using an HAMD-24 cutoff of 35 are presented in Table 4. An ESM-PSD total score of 35.5 corresponds with the maximum Youden index (0.691), with a corresponding sensitivity and specificity of 93.8% and 63.1%, respectively. For this ESM-PSD score, the area under the ROC curve is 0.872 (95% CI [0.804, 0.941]). Next, we used an ESM-PSD cutoff score of 35.5 to divide the post-stroke patients into two groups. An independent-sample t-test comparison of subgroup means showed statistically significant symptom differences, \( t(137) = 19.421, p < .001 \), between post-stroke patients with moderate symptoms (\( M = 14.15, SD = 8.47 \)) and post-stroke patients with severe symptoms (\( M = 44.29, SD = 13.16 \)). These results support using an ESM-PSD cutoff score of 35.5 to distinguish post-stroke patients with moderate depressive symptoms from post-stroke patients with severe depressive symptoms.
### TABLE 4.
The Raw Score, Sensitivity, Specificity, and Youden Index of the Early Symptom Measurement of Post-Stroke Depression (ESM-PSD) According to Hamilton Rating Scale for Depression-24 (HAMD-24) Cutoffs (N = 139)

| ESM-PSD Raw Scores | Sensitivity | Specificity | Youden Index | ROC Curve |
|--------------------|-------------|-------------|--------------|-----------|
| HAMD-24 cutoff 8    |             |             |              |           |
| 4.6                | 0.976       | 0.400       | 0.376        |           |
| 5.5                | 0.968       | 0.467       | 0.435        |           |
| 6.5                | 0.968       | 0.533       | 0.501        |           |
| 7.5                | 0.952       | 0.533       | 0.485        |           |
| 8.5                | 0.952       | 0.600       | 0.552        |           |
| 9.5                | 0.944       | 0.600       | 0.544        |           |
| 11.5               | 0.944       | 0.600       | 0.744        |           |
| 14.5               | 0.944       | 0.867       | 0.811        |           |
| 16.5               | 0.911       | 0.867       | 0.778        |           |
| 17.0               | 0.903       | 0.867       | 0.770        |           |
| 17.5               | 0.895       | 0.867       | 0.762        |           |
| 18.2               | 0.887       | 0.867       | 0.754        |           |
| 18.7               | 0.879       | 0.867       | 0.746        |           |
| 19.1               | 0.863       | 0.867       | 0.730        |           |
| 19.6               | 0.855       | 0.867       | 0.722        |           |
| HAMD-24 cutoff 20   |             |             |              |           |
| 21.1               | 0.962       | 0.492       | 0.454        |           |
| 21.6               | 0.962       | 0.508       | 0.470        |           |
| 22.5               | 0.949       | 0.557       | 0.506        |           |
| 23.2               | 0.949       | 0.574       | 0.523        |           |
| 23.4               | 0.949       | 0.590       | 0.539        |           |
| 23.7               | 0.949       | 0.607       | 0.556        |           |
| 24.5               | 0.949       | 0.639       | 0.588        |           |
| 25.5               | 0.923       | 0.672       | 0.595        |           |
| 26.2               | 0.885       | 0.689       | 0.574        |           |
| 26.7               | 0.885       | 0.705       | 0.590        |           |
| 27.0               | 0.872       | 0.721       | 0.593        |           |
| 27.5               | 0.859       | 0.721       | 0.580        |           |
| 28.5               | 0.821       | 0.721       | 0.542        |           |
| 29.5               | 0.808       | 0.721       | 0.529        |           |
| 30.1               | 0.795       | 0.721       | 0.516        |           |
| HAMD-24 cutoff 35   |             |             |              |           |
| 39.5               | 1.000       | 0.714       | 0.714        |           |
| 40.5               | 1.000       | 0.739       | 0.739        |           |
| 41.5               | 1.000       | 0.748       | 0.748        |           |
| 42.7               | 1.000       | 0.756       | 0.756        |           |
| 43.2               | 1.000       | 0.765       | 0.765        |           |
| 43.7               | 1.000       | 0.773       | 0.773        |           |
| 44.5               | 1.000       | 0.782       | 0.782        |           |
| 45.5               | 1.000       | 0.798       | 0.798        |           |
| 46.2               | 0.900       | 0.815       | 0.715        |           |
| 46.7               | 0.900       | 0.824       | 0.724        |           |
| 47.5               | 0.850       | 0.832       | 0.682        |           |
| 48.5               | 0.800       | 0.840       | 0.640        |           |
| 49.5               | 0.600       | 0.857       | 0.457        |           |
| 50.5               | 0.500       | 0.882       | 0.382        |           |
| 52.0               | 0.500       | 0.891       | 0.391        |           |

Note. ROC = receiver operating characteristic; AUC = area under the curve.
HAMD-24 cutoff score of 35 are presented in Table 4. A total ESM-PSD score of 45.5 corresponds to the maximum Youden index (0.798), with a corresponding sensitivity and specificity of 100.0% and 79.8%, respectively. For this ESM-PSD score, the area under the ROC curve is 0.894 (95% CI [0.842, 0.946]). This ESM-PSD score divides the post-stroke patients into two groups. An independent-sample t test, t(97.781) = 14.717, p < .001, showed statistically significant differences between post-stroke patients with moderate depressive symptoms (M = 24.51, SD = 12.57) and post-stroke patients with severe depressive symptoms (M = 54.80, SD = 10.65). These results show that an ESM-PSD cutoff score of 45.5 distinguishes between post-stroke patients with moderate depressive symptoms and severe depressive symptoms.

**Mean Differences Between Depression Severity Levels of Hamilton Rating Scale for Depression-24 and Early Symptom Measurement of Post-Stroke Depression**

The one-way ANOVA results showed significant differences between the different depression levels divided by the cutoff scores of HAMD-24 and ESM-PSD (Table 5). Furthermore, post hoc results revealed that the depression levels divided by the cutoff scores of HAMD-24 and ESM-PSD were significantly different from the other groups. This result indicates that the cutoff scores of ESM-PSD determined by the cutoff scores of HAMD-24 distinguish different levels of depression adequately.

In summary, we used the ROC curve to evaluate the specificity, sensitivity, and Youden index of the ESM-PSD cutoff scores (Tables 4 and 5). The ESM-PSD cutoff scores showed the expected correspondence with mild–moderate–severe HAMD-24 symptoms with high area under the curve evidence. Furthermore, the one-way ANOVA confirmed significant differences between different levels of depression and thus proved the effectiveness of ESM-PSD cutoff scores in distinguishing different levels of PSD.

**Clinical Agreement in the Early Symptom Measurement of Post-Stroke Depression and the Hamilton Rating Scale for Depression-24**

The Kappa coefficient for the ESM-PSD and HAMD-24 was .454 (p < .001). This level of agreement is lower than the accepted criteria of .75 because a moderate level of statistically significant agreement reflects accurately the similarities and differences between two diagnostic measures in a sample of acute post-stroke patients assessed for symptoms of early-stage PSD. Although both of the scales measure negative changes in thought and mood, the ESM-PSD further measures the attribution of these negative changes to “acute post-stroke” as the underlying condition.

**Discussion**

In a sample of hospital patients who were, on average, less than 2 weeks post-stroke, we examined ESM-PSD internal consistency, concurrent criterion validity, and cut-off scores. Accepted statistical tests show the ESM-PSD total score, and six domains have acceptable levels of internal consistency and, using the HAMD-24 as the gold standard, acceptable criterion validity, as a measure of clinically relevant symptoms of early-stage PSD in the patients with acute stroke. As described in the Results section, some HAMD-24 domains did not reach the .70 criteria for internal consistency: psychomotor retardation = .26, sleep disorders = .52, and desperation = .69. These findings may be expected given that HAMD-24 items are designed primarily to identify major depression. Patients with stroke experiencing early-stage PSD are unlikely to have symptoms of psychomotor retardation, hypersomnia, or desperation. Thus, these were the three domains of the HAMD-24 that showed relatively low internal consistency in the participants. Early-stage PSD is distinct from major depression, yet PSD has been shown to increase the risk of late-onset major depression, suicidality, and limited functional recovery. Therefore, the level of the correlations and explanatory

| Depression Level | HAMD-24 | ESM-PSD (ROC) |
|------------------|---------|--------------|
|                  | Cutoff  | n  | %    | M    | SD | F    | p   | Cutoff  | n  | %    | M    | SD | F    | p   |
| No               | 0       | 17 | 12.2 | 5.30 | 2.11 | 312.219 | <.001 | 0       | 20 | 14.4 | 5.26 | 3.91 | 259.673 | <.001 |
| Mild             | 8       | 38 | 27.3 | 14.06 | 3.21 | 14.5 | 27 | 19.4 | 20.73 | 3.16 |
| Moderate         | 19      | 64 | 46.0 | 25.39 | 4.41 | 25.5 | 48 | 34.5 | 34.65 | 5.77 |
| Severe           | 35      | 20 | 14.4 | 41.99 | 5.66 | 45.5 | 44 | 31.7 | 54.80 | 10.65 |
The strong, positive correlation ($r = .689$) found for ESM-PSD and HAMD-24 total scores is evidence of concurrent criterion validity, whereas the interesting domain correlations that were found suggest areas of measurement where the similarity between these two measures end. The ESM-PSD low domain positively correlated with all of the domains of the HAMD-24. This finding suggests that, in acute post-stroke patients, the low domain of the ESM-PSD may measure an early-stage core symptom of PSD or subclinical major depression. The ESM-PSD dull domain positively correlated with all domains of the HAMD-24, except for the HAMD-24 day–night change domain. The ESM-PSD screens patients with acute stroke for early symptoms of stroke-related depression. In earlier item development research, neither patients nor experts recommended the concept of day–night change as an early symptom of PSD (Li et al., 2018). The ESM-PSD guilt domain and emotional domain positively correlated with the HAMD-24 desolation domain. Stroke-related guilt appears to be a common experience among patients with acute stroke. It is possible that this domain addresses a second early-stage core symptom of PSD. The ESM-PSD wakefulness and nervous domains were positively correlated with all of the HAMD-24 domains. Sleep changes and excessive biopsychosocial arousal and worry are symptoms commonly used to diagnose major depression. However, in the acute post-stroke patient, these symptoms may reflect understandable sense of alarm in response to a health event such as stroke.

In this study, the ROC model was used to define ESM-PSD cutoff scores because this method of analysis allows evaluation of the clinical relevance of these scores. Based on the results, it is recommended that these cutoff scores be used to assess newly admitted, acute post-stroke patients who do not require intensive care. The aim of this research was to develop a measure that is able to detect early symptoms of stroke-related depression in post-stroke patients early enough for the patient to receive prompt psychological care to reduce the risk of stroke-related major depression, suicidality, and impaired psychosocial functioning. According to the cutoff scores defined by the ROC curve, 80% of the participants met the criteria for early-stage PSD (Table 5), a rate that reflects the PSD incidence rates found in other studies. Although the immediate management of the physical symptoms of stroke is still the treatment priority, the depression-related morbidity and mortality associated with mild-to-moderate stroke makes PSD a second, but equal, priority. The lower Kappa coefficient (.454) for ESM-PSD and HAMD-24 is expected because, whereas the HAMD-24 measures general depression, the ESM-PSD measures disease-specific depression for patients with stroke. Furthermore, the lower Kappa coefficient for the two measures indicates that the disease-specific depression in patients with stroke as measured by ESM-PSD is different from general depression as measured by HAMD-24. Therefore, the development of ESM-PSD is required urgently to assess early-stage stroke-related depression accurately. Further research will help determine whether the ESM-PSD measures specific early symptoms of clinical depression in patients with acute stroke or early symptoms of PSD that increase the risk of clinical depression within 6 months (Berg et al., 2009; Meng et al., 2017; Yang et al., 2013).

Research shows that high HAMD-24 scores ($OR = 2.38$, $95\%$ CI [1.61, 3.50], $p < .001$) independently predict increased risk of PSD (Meng et al., 2017). Three scales, including the Center for Epidemiological Studies Depression Scale, the HAMD-24, and the Patient Health Questionnaire-9, are currently regularly used to screen post-stroke patients for PSD, although each appears to be an unsatisfactory screen for case finding (Meador, Moe-Byrne, Llewellyn, & Mitchell, 2014; Rogers, 2017). This limitation is critical. PSD screens must be clinically effective, meaning that a screen must generate a score that may be used to decide when preventive interventions are needed. The findings of this study suggest that an ESM-PSD score of 14.5 shows treatment levels of early-stage PSD.

**Limitations**

A major limitation of this study was the use of HAMD-24 cutoff scores as the gold standard for determining clinically relevant cutoffs for the ESM-PSD. However, the HAMD-24 is a recognized interview screen for depression in both clinical and research populations. A different depression screen may yield a different ESM-PSD cutoff score, although it is unlikely that the symptom level associated with that score would differ significantly. To further test the clinical relevance of the ESM-PSD cutoff scores, future research has already been planned to cross-validate the ESM-PSD cutoff scores according to diagnostic results by the clinical specialists (Lam et al., 2017).

**Conclusion**

The major findings of this study permit the researchers to proceed with planned studies of measurement invariance in a similar sample of U.S. patients with acute stroke and a 3-, 6-, and 9-month follow-up comparison tests of ESM-PSD score as a predictor of increased risk for depressive illness.

**Relevance to Clinical Practice**

The clinical relevance of this study is the finding that the ESM-PSD is able to detect the early symptoms of PSD in patients with acute stroke at clinically relevant levels of symptom severity. Nurses who recognize dysphoric emotional distress in a newly admitted post-stroke patient are more likely to act on their clinical observation by screening the patient for ESM-PSD if an accurate, easy-to-use assessment tool is available.

**Acknowledgments**

The authors acknowledge the following agencies who provided financial support to this study: the National Natural Science...
Foundation of China (Grant Number 71804134), the Natural Science Foundation of Zhejiang Province (Grant Number LQ18G030006), the Project of Humanities and Social Sciences from the Ministry of Education in China (Grant Number 18YJCZH078), the Wenzhou Science and Technology Bureau (Grant Number Y20180054), and the Health Commission of Zhejiang Province (Grant Number 2020KY631).

Author Contributions

Study conception and design: JL, YLuo
Data collection: YLi
Data analysis and interpretation: RLB
Drafting of the article: JL
Critical revision of the article: LDO

Accepted for publication: June 12, 2019
*Address correspondence to: Yong LUO, No. 1, Youyi Road, Yuanjiagang, Yuzhong District, Chongqing, PRC. Tel: +86 138-960-07588; E-mail: 45042915@qq.com
The authors have no conflict of interest to disclose.

Cite this article as:
Li, J., Oakley, L., Brown, R., Li, Y., & Luo, Y. (2020). Properties of the Early Symptom Measurement of Post-Stroke Depression: Concurrent criterion validity and cutoff scores. The Journal of Nursing Research, 28(4), e107. https://doi.org/10.1097/jnr.0000000000000380

References

Aben, I., Verhey, F., Lousberg, R., Lodder, J., & Honig, A. (2002). Validity of the Beck Depression Inventory, Hospital Anxiety and Depression Scale, SCL-90, and Hamilton Depression Rating Scale as screening instruments for depression in stroke patients. Psychosomatics, 43(5), 386–393. https://doi.org/10.1176/appi.ps.43.5.386
Bagby, R. M., Ryder, A. G., Schuller, D. R., & Marshall, M. B. (2004). The Hamilton Depression Rating Scale: Has the gold standard become a lead weight? The American Journal of Psychiatry, 161(12), 2163–2177. https://doi.org/10.1176/appi.ajp.161.12.2163
Bartoli, F., Lillia, N., Lax, A., Crocamo, C., Mantero, V., Carrà, G., ... Clerici, M. (2013). Depression after stroke and risk of mortality: A systematic review and meta-analysis. Stroke Research and Treatment, 2013, Article ID 862978. https://doi.org/10.1155/2013/862978
Berg, A., Lännqvist, J., Palomäki, H., & Kaste, M. (2009). Assessment of depression after stroke: A comparison of different screening instruments. Stroke, 40(2), 523–529. https://doi.org/10.1161/strokea.108.527705
Coronado, P. J., Sanchez-Borrego, R., Ruiz, M. A., Baquedano, L., Sánchez, S., Argudo, C., ... Rejas, J. (2016). Psychometric attributes of the Cervantes short-form questionnaire for measuring health-related quality of life in menopausal women. Maturitas, 84, 55–62. https://doi.org/10.1016/j.maturitas.2015.10.013
DeSimone, J. A., Harms, P. D., Vanhove, A. J., & Herian, M. N. (2017). Development and validation of the Five-by-Five Resilience Scale. Assessment, 24(6), 778–797. https://doi.org/10.1177/1073191116625803
Dwyer Hollender, K. (2014). Screening, diagnosis, and treatment of post-stroke depression. The Journal of Neuroscience Nursing, 46(3), 135–141. https://doi.org/10.1016/j.jnn.2014.01.004
Gao, Q. (2015). The incidence and correlated factors of acute post-stroke depression (Unpublished master’s thesis). Jilin University, PRC. (Original work published in Chinese)
Houser, J. (2013). Nursing research: Reading, using and creating evidence (3rd ed.). Burlington, MA: Jones & Bartlett Learning.
Kang, H. J., Stewart, R., Kim, J. M., Jang, J. E., Kim, S. Y., Bae, K. Y., ... Yoon, J. S. (2013). Comparative validity of depression assessment scales for screening poststroke depression. Journal of Affective Disorders, 147(1–3), 186–191. https://doi.org/10.1016/j.jad.2012.10.035
Koositamongkol, S., Sindhu, S., Pinyopasakul, W., Nilanont, Y., & Redman, R. W. (2013). Factors influencing functional recovery in patients with acute ischemic stroke. Collegian, 20(4), 207–213. https://doi.org/10.1016/j.colleg.2012.09.002
Lam, S. C., Yeung, C. C. Y., Chan, J. H. M., Lam, D. W. C., Lam, A. H. Y., Annesi-Maesano, I., & Bousquet, J. (2017). Adaptation of the score for allergic rhinitis in the Chinese population: Psychometric properties and diagnostic accuracy. International Archives of Allergy Immunology, 173(4), 213–224. https://doi.org/10.1159/000477727
Lewin-Richter, A., Volz, M., Jobges, M., & Werheide, K. (2015). Predictivity of early depressive symptoms for post-stroke depression. The Journal of Nutrition, Health & Aging, 19(7), 754–758. https://doi.org/10.1007/s12603-015-0540-x
Li, J. (2016). Development of the post-stroke early screening tool and its preliminary application (Unpublished doctoral dissertation). Chongqing Medical University, PRC. (Original work published in Chinese)
Li, J., Oakley, L. D., Brown, R. L., Li, Y., Ye, M., & Luo, Y. (2016). Early Symptom Measurement of Post-Stroke Depression (PSD). Journal of Affective Disorders, 197, 215–222. https://doi.org/10.1016/j.jad.2016.03.038
Li, J., Oakley, L. D., Li, Y., & Luo, Y. (2018). Development and initial validation of a clinical measure to assess early symptoms of post-stroke depression in the acute stroke patient. Journal of Clinical Nursing, 27(3–4), 784–794. https://doi.org/10.1111/jocn.14099
Maggino, L., Malleo, G., Bassi, C., Allegrini, V., Beane, J. D., Beckman, R. M., ... Vollmer, C. M. Jr. (2019). Identification of an optimal cut-off for drain fluid amylase on postoperative day 1 for predicting clinically relevant fistula after distal pancreatectomy: A multi-institutional analysis and external validation. Annals of Surgery, 269(2), 337–343. https://doi.org/10.1097/SLA.0000000000002532
Meader, N., Moe-Byrne, T., Llewellyn, A., & Mitchell, A. J. (2014). Screening for poststroke major depression: A meta-analysis of diagnostic validity studies. Journal of Neurology, Neurosurgery and Psychiatry, 85(2), 198–206. https://doi.org/10.1136/jnnp-2012-304194
Meng, G., Ma, X., Li, L., Tan, Y., Liu, X., Liu, X., & Zhao, Y. (2017). Predictors of early-onset post-ischemic stroke depression: A cross-sectional study. BMC Neurology, 17(1), Article number 199. https://doi.org/10.1186/s12883-017-0980-5
Mitchell, A. J., Sheth, B., Gill, J., Yadeagarfar, M., Stubbs, B., Yadeagarfar, M., & Meader, N. (2017). Prevalence and predictors of post-stroke mood disorders: A meta-analysis and meta-regression of depression, anxiety and adjustment disorder. General Hospital Psychiatry, 47, 48–60. https://doi.org/10.1016/j.genhosppsych.2017.04.001
Moon, K. J., Jin, Y., Jin, T., & Lee, S. M. (2017). Development and validation of an automated delirium risk assessment system (auto-DeRAS) implemented in the electronic health record system. International Journal of Nursing Studies, 77, 46–53. https://doi.org/10.1016/j.ijnurstu.2017.09.014
Pan, S., Liu, Z. W., Shi, S., Ma, X., Song, W. Q., Guan, G. C., ... Lv, Y. (2017). Hamilton Rating Scale for Depression-24 (HAM-D24) as a novel predictor for diabetic microvascular complications in Type 2 diabetes mellitus patients. Psychiatry Research, 258, 177–183. https://doi.org/10.1016/j.psychres.2017.07.050

Robinson, R. G., & Jorge, R. E. (2015). Post-stroke depression: A review. The American Journal of Psychiatry, 173(3), 221–231. https://doi.org/10.1176/appi.ajp.2015.15030363

Rogers, S. C. (2017). Poststroke depression screening: An executive summary. The Journal of Neurosciences Research, 49(2), 66–68. https://doi.org/10.1097/01.NURSE.0000000000000270

Schulte-Altedorneburg, M., & Bereczki, D. (2014). Post-stroke depression: A cross-sectional study. BMC Psychiatry, 13(1), 164. https://doi.org/10.1186/1471-244X-13-164

Shi, Y. Z., Xiang, Y. T., Yang, Y., Zhang, N., Wang, S., Ungvari, G. S., ... Wang, C. (2015). Depression after minor stroke: Prevalence and predictors. Journal of Psychosomatic Research, 79(2), 143–147. https://doi.org/10.1016/j.jpsychres.2015.03.012

Shi, Y. Z., Xiang, Y. T., Yang, Y., Zhang, N., Wang, S., Ungvari, G. S., ... Wang, C. X. (2016). Depression after minor stroke: The association with disability and quality of life—a 1-year follow-up study. International Journal of Geriatric Psychiatry, 31(4), 421–427. https://doi.org/10.1002/gps.4353

Sun, X. Y., Li, Y. X., Yu, C. Q., & Li, L. M. (2017). Reliability and validity of depression scales of Chinese version: A systematic review. Zhonghua Liu Xing Bing Xue Za Zhi, 38(1), 110–116. https://doi.org/10.3760/cma.j.issn.0254-6450.2017.01.021 (Original work published in Chinese)

Tang, W., Hu, J., Zhang, H., Wu, P., & He, H. (2015). Kappa coefficient: A popular measure of rater agreement. Shanghai Archives of Psychiatry, 27(1), 62–67. https://doi.org/10.11919/j.issn.1002-0829.215010 (Original work published in Chinese)

Tateno, A., Kimura, M., & Robinson, R. G. (2002). Phenomenological characteristics of poststroke depression: Early versus late-onset. The American Journal of Geriatric Psychiatry, 10(5), 575–582. https://doi.org/10.1097/00019442-200209000-00011

Towfighi, A., Ovbiagele, B., El Husseini, N., Hackett, M. L., Jorge, R. E., Kissela, B. M., ... Williams, L. S. (2017). Poststroke depression: A scientific statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke, 48(2), e30–e43. https://doi.org/10.1161/STR.0000000000000113

Yang, S. R., Hua, P., Shang, X. Y., Hu, R., Mo, X. E., & Pan, X. P. (2013). Predictors of early post ischemic stroke apathy and depression: A cross-sectional study. BMC Psychiatry, 13(1), 164. https://doi.org/10.1186/1471-244X-13-164

Yuan, H. W., Wang, C. X., Zhang, N., Bai, Y., Shi, Y. Z., Zhou, Y., ... Wang, Y. J. (2012). Poststroke depression and risk of recurrent stroke at 1 year in a Chinese cohort study. PLOS ONE, 7(10), e46906. https://doi.org/10.1371/journal.pone.0046906

Yue, Y. (2017). The study of evaluation, diagnostic criteria, risk prediction, and biomarkers for post-stroke depression (Unpublished doctoral dissertation). Dongnan University, PRC. (Original work published in Chinese)

Zhai, S., Mahir, L., Azanmasso, H., Lmidmani, F., & El Fatimi, A. (2016). Anxiety and depression after stroke: Report of 64 cases. Annals of Physical and Rehabilitation Medicine, 59S, e76. https://doi.org/10.1016/j.rehab.2016.07.178

Zhang, Y., Zeng, L., & Liu, J. (2015). Analysis of the incidence of early depression and its influencing factors after stroke. Chinese Journal of Modern Nervous Diseases, 153(3), 203–208. (Original work published in Chinese)

Zheng, Y. P., Zhao, J. P., Phillips, M., Liu, J. B., Cai, M. F., Sun, S. Q., & Huang, M. F. (1988). Validity and reliability of the Chinese Hamilton Depression Rating Scale. The British Journal of Psychiatry, 152(5), 660–664. https://doi.org/10.1192/bjp.152.5.660

Zhu, G., Yin, Y., Xiao, C. L., Mao, R. J., Shi, B. H., Jie, Y., & Wang, Z. W. (2015). Serum DHEAS levels are associated with the development of depression. Psychiatry Research, 229(1–2), 447–453. https://doi.org/10.1016/j.psychres.2015.05.093