A Validation Study of Two Brief Measures of Depression in the Cardiac Population: The DMI-10 and DMI-18

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The authors report on the psychometric characteristics and clinical efficacy of two versions of a recently developed screening measure of depression (the DMI-18 and DMI-10) in the cardiac population. Patients with acute coronary syndrome or heart failure (N = 322) completed the DMI measures, psychosocial questionnaires, and a semistructured clinical interview during the hospital stay. The DMI-18 and DMI-10 measures have adequate psychometric properties, demonstrating high sensitivity and specificity when evaluated against clinical judgment based on a semistructured interview. The DMI-18 and DMI-10 are appropriate for use as screening instruments in cardiac patients. (Psychosomatics 2006; 47:129–135)

Depression is a common experience for those suffering from a cardiac illness. In patients with coronary artery disease, prevalence estimates for major depression after myocardial infarction (MI) range between 15% and 22%, and another 25% experience minor depression.[1] For hospitalized patients with congestive heart failure, 17%–37% are estimated to meet criteria for a major depressive episode, and a further 16%–22% meet criteria for minor depression.[2] In addition to its being prevalent, several lines of evidence suggest that depression is also associated with increased morbidity and mortality in patients with coronary artery disease and heart failure[3–6] and that pre-cardiac depression confers a greater risk of developing coronary artery disease above and beyond the risk contributed by physiological cardiac risk factors.[7,8] Even for levels of depression not considered clinically meaningful, higher cardiac mortality rates persist.[9] However, depression is still rarely assessed and infrequently treated in cardiac clinical practice. Estimates suggest that fewer than 25% of cardiac patients with major depression are accurately diagnosed, and, of those, approximately one-half do not receive appropriate treatment for depression.[10] The impact of depression on the development and prognosis of cardiac disease makes detecting depression (both major and minor) in cardiac patients a pertinent issue. Given that depression is currently underrecognized by clinicians in cardiology departments, a pencil-and-paper measure, because of its ease of administration, may be the optimal way to screen for this risk factor.

Validation of Depression Measures in a Cardiac Population

Although many depression rating scales have been used in cardiac patients, few measures have been validated

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specifically for this population. A recent study by Strik and colleagues[11] demonstrates the importance of population-specific validation. They tested three commonly used pencil-and-paper depression measures in a cardiac sample and found that these measures could not simply be applied to the cardiac population at their generally recommended cutoff points. For the Hospital Anxiety and Depression Scale (HADS), they established a cutoff score of 3 or 4 for the Depression subscale (HADS–D), rather than the usually applied 7or 8 cutoff. Discrepancies in cutoffs for the two other self-report measures of depression (the 90-item Symptom Checklist [SCL–90], and the Beck Depression Inventory [BDI]) were also found, and lower cutoff points were recommended.

The Depression in the Medically Ill (DMI-18 and DMI-10) Measures

The Depression in the Medically Ill-18 and The Depression in the Medically Ill-10 (DMI-18 and DMI-10) were developed with the key objectives of deriving brief and valid screening measures for depression with items independent of medical-illness features, so that "somatic" (or physical) items were excluded. The initial development study was undertaken in a heterogeneous group of medical inpatients.[12] A follow-up study was subsequently undertaken[13] to test the validity of the 18-item measure (DMI-18), which also generated a shorter, 10-item version (DMI-10). Also, their psychometric properties were further tested in a large sample of patients visiting general practitioners.[14] A copy of the DMI-18 appears in Appendix 1. Items are scored: 0: Not True; 1: Slightly True; 2: Moderately True; and 3: Very True. Items are then summed for a total score. Items 1, 2, 9, 11, 12, 13, 14, 15, 16, and 18 comprise the DMI-10, which is scored in the same manner.

Although one strategy for validating pencil-and-paper depression measures for the medical population has been to test them in heterogeneous medically ill groups, it would be ideal to also validate these measures within cardiac samples. Furthermore, as Strik et al.'s recent study[11] demonstrates, the cutoff points for a measure validated in a heterogeneous medical sample may, in fact, be very different in a homogeneous medical sample. Hence, the current project aimed to test the criterion and construct validity of the DMI-18 and DMI-10 within the cardiac population, and to determine appropriate cutoff scores for use as a research instrument and screening tool.

METHOD

A group of 322 patients with acute coronary syndrome or heart failure were recruited between May 2001 and July 2003 during their inpatient admission to the Cardiology Department at Prince of Wales Hospital. Inclusion criteria were suffering from acute coronary syndrome or heart failure requiring hospitalization for more than 2 days, and being in stable condition. Exclusion criteria for the study were known cognitive impairments, difficulty reading and writing in English, and hearing or visual impairments. Of our 322 patients, 266 (82.6%) were currently admitted for acute coronary syndrome, 13 (4%) for heart failure, and 43 (13.4%) for both acute coronary syndrome and heart failure. These patients were a nonrandom sample who were part of a larger consecutive sample of patients participating in a depression and cardiac morbidity study. In all, 895 patients were approached for the study; 550 participated, 257 were excluded (most often due to non–English-speaking background), and 88 refused participation. Unfortunately, because of the logistics of the hospital setting (patients being discharged, visitors present, patients' leaving for procedures), not all 550 participants filled out their questionnaire booklet during their hospital stay; hence, our data are from 322 of 550 who did complete and return their booklet during their hospital stay. Each consenting patient received a semistructured clinical interview with a Research Psychologist or Research Assistant at least 24 hours after their admission, assessing traditional cardiac risk factors and current anxiety and depression. Patients were also asked to complete the DMI-18 and DMI-10 measures and a battery of psychosocial measures.

Measures

Criterion validity measure: The Depression and Anxiety sections of the Composite International Diagnostic Interview (CIDI), Version 2.1[15] were administered in the context of a semistructured clinical interview. The psychometric properties of the CIDI have been reviewed, and test–retest reliabilities (κ) for the depression module have been reported from pooled samples (N = 575) of between 0.52 (Dysthymia) to 0.66 (single episode of major depression), with a very good agreement of 0.71 for "any depressive disorder," by use of DSM-III-R diagnoses.[16] In terms of construct validity, good diagnostic concordance for any diagnosis of a depressive disorder was found for three studies, with κs ranging from 0.70 to 0.84; the highest was found in a small sample of primary-practice attendees.[16] In the medical inpatient setting,[17] the κ between the LEAD gold standard suggested by Spitzer (a combination of symptomatology, clinical consensus, and other measures) and the CIDI depression section was very good (κ = 0.67).

The diagnosis of lifetime major depression had a very good positive predictive value (82%), but was somewhat lower for current major depression (62%), which is a moderately good positive predictive value and which authors felt may have been an artifact of the limited number of patients found to have a depressive disorder by the LEAD criteria. However, a good negative predictive value (90%) was found for current depression. Authors concluded that, given the difficulties inherent in diagnosing depression in a medical sample, the CIDI did very well against their gold standard. In our study, results of the CIDI Depression section were combined with clinical judgment in order to have a criterion standard against which to test the DMI-18 and DMI-10. Because the CIDI captures major depression and dysthymia only, clinical judgment was used to supplement information gathered through the CIDI administration to classify patients as belonging to one of five categories that characterized their current mood state: that is, Not Depressed, Minor Depression, Dysthymia, Major Depressive Episode, and Bereavement. This information was dichotomized so that individuals were assessed as either a "case" of depression (including those with minor depression and current bereavement), or a "non-case" of depression.

Convergent validity measures: It was anticipated that high levels of anxiety, low levels of social support, and high levels of concern regarding illness outcome would be associated with depression. To this end, we administered the following scales:

The Anxiety subscale of The Hospital Anxiety and Depression Scale (HADS–A):[18] This scale was developed to screen anxiety in the hospital setting, and it consists of 7 items (rated 0–3), yielding a score from 0 to 21. The HADS–A has had its psychometric properties examined in the cardiac population, where it demonstrates very good internal reliability (0.84–0.86) and excellent test–retest reliability.[19] Although there is some debate over the factor solution for the measure as a whole, confirmatory factor analysis demonstrated that 4 of the Anxiety items loaded on Psychic Anxiety, and the other 3 loaded on Psychomotor Agitation. Authors suggest that this may represent two distinct facets of anxiety—cognitive and autonomic. However, for the purposes of this study, we used an overall score on both these factors of anxiety.

The Multidimensional Scale of Perceived Social Support (MSPSS) is a brief measure of perceived social support consisting of three subscales assessing social support from friends, significant others, and family members. Items are rated on a 7-point Likert scale. The subscale structure has been validated with a principal-components factor analysis and has reported coefficient αs for the subscales and total scale ranging from 0.85 to 0.91, indicating good internal reliability, and test–retest reliability of 0.72 to 0.85.[20]

The Illness Perception Questionnaire (IPQ)[21] measures five dimensions of illness representations. We administered the Consequences scale to assess patients' perception of outcome of their cardiac condition. The 7 items are scored on a 5-point Likert scale. The Consequences scale was found to have a high level of internal consistency (Cronbach α: 0.82), and test–retest reliability ranged from 0.68, at 1month, to 0.55, at 6 months, in a sample of medical patients.[21]

Divergent validity measures: Disease severity has not been found to bear any relation to depression in the cardiac population,[22–26] so it was therefore chosen as a measure of divergent validity.

Left-ventricular functioning (LVF) from a resting M Mode 2 dimensional trans-thoracic echocardiography was recorded to assess disease severity. Visual estimates of left-ventricular systolic functioning were made during the echocardiogram, and patients were classified as 1: normal; 2: mild impairment; 3: mild-to-moderate impairment; 4: moderate impairment; 5: moderate-to-severe impairment; and 6: severe impairment. LVF has been used in numerous studies to quantify disease severity.[23,24,27]

Severity of coronary artery disease was rated according to the number and extent of diseased vessels found on angiography (0: no significant coronary artery disease, or minor coronary artery disease, $<50\%$; 1: single-vessel disease $\geq 50\%$ stenosed; 2: double vessel disease, with stenosis $\geq 50\%$; 3: triple vessel disease, with stenosis $\geq 50\%$).

Number of previous cardiac admissions was used as an indication of disease severity and coded as: number of ischemic admissions, number of heart failure admissions, and number of total cardiac admissions, including the current admission.

RESULTS

The reliability of the measures were examined using Cronbach's α coefficient to determine internal consistency. Criterion validity was quantified with Spearman's correlations, and sensitivity and specificity estimates were derived from a Receiver Operating Characteristic (ROC) curve.

The sample comprised 322 participants between 28 and 89 years old (mean age: 65.7 years); 83.9% were suffering from acute coronary syndrome, 10.6% were suffering from heart failure, and 5.3% were suffering from both.

The sample was predominately male (71.1%). There were no significant differences between genders in age, marital status, employment, years of education, or occupation: 63.9% were married, 15.0% were widowed, 13.8% were divorced or separated, and 6.9% were single. With regard to occupational functioning, 36.8% were retired, 32.1% were pensioners, 23.2% were employed full-time or part-time, 6.0% were engaged in home duties, and 1.9% were unemployed. The mean years of education from primary through to tertiary education was 10.9 years (range: 1 to 26 years).

At the time of the interview, 8.3% of men and 5.4% of women were judged to be suffering from minor depression, and 10.9% of men and 11.8% of women were suffering from major depression or dysthymia, according to CIDI-generated DSM-IV diagnoses and clinical interview.

Construct Validity

The DMI-18 and DMI-10 exhibited good internal consistency in the cardiac sample (Cronbach α coefficient: $\alpha = 0.93$ and 0.89, respectively).

Spearman correlations for convergent validity were all significant (Table 1). The DMI-18 and DMI-10 converged with anxiety (by HADS–A) to a moderate extent. Both measures exhibited low-negative correlations with all subscales of perceived social support (MSPSS), and converged modestly with patients' subjective appraisal of their illness's consequences (IPQ).

Discriminant Validity

Both measures showed no correlation with our three measures of disease severity: LVF, number of diseased vessels, and number of hospital admissions (Table 1).

Criterion Validity

With the CIDI semistructured interview and clinical judgment as the combined standard for a depression "case," ROC curves for the total DMI-18 and DMI-10 scores were generated and are recorded in Table 2. The area under the curve (AUC) revealed that the overall accuracy of both measures with respect to discriminating depression "caseness" was good. The point of maximum curvature of the ROC analyses suggested that a cutoff score ≥ 14 yielded the best trade-off between sensitivity and specificity for the DMI-18, correctly classifying 79.1% of the sample and producing a positive predictive value (PPV) of 47.5% and a negative predictive value (NPV) of 93.0%. The optimal cutoff point for the DMI-10 was ≥ 6, correctly classifying 73.3% of the population, with a PPV of 40.2% and an NPV of 93.1%.

When the Case criterion was changed to exclude minor depression, the same cutoff points emerged as optimal for both measures and produced similar sensitivity, specificity, and classification rates (Table 2).

DISCUSSION

Both the DMI-18 and DMI-10 demonstrated acceptable psychometric characteristics in this cardiac sample. Good

TABLE 1. Psychometric Characteristics of the DMI-10 and DMI-18 With Convergent and Divergent Validity Measures

Validity	DMI-10	p	DMI-18	p
Convergent measures				
HADS–A	0.56	<0.001	0.57	<0.001
MSPSS				
Total scale	−0.23	<0.001	−0.24	<0.001
Family scale	−0.17	<0.001	−0.18	<0.001
Friends scale	−0.22	<0.001	−0.22	<0.001
Significant Other scale	−0.22	<0.001	−0.22	<0.001
IPQ (consequences scale)	0.26	<0.001	0.29	<0.001
Divergent measures				
Left ventricular function	−0.02	0.69	−0.02	0.73
Number of diseased vessels	0.08	0.19	0.08	0.21
Number of hospital admissions				
IHD (N = 307)	0.04	0.46	0.03	0.59
HF (N = 52)	−0.21	0.13	−0.22	0.13
Total cardiac admissions (N = 322)	−0.01	0.83	−0.03	0.54

Note: DMI: Depression in the Medically Ill; HADS–A: Hospital Anxiety and Depression Scale; MSPSS: Multidimensional Scale of Perceived Social Support; IPQ: Illness Perception Questionnaire; IHD: ischemic heart disease; HF: heart failure.

TABLE 2. Receiver Operating Characteristics (ROC) for the DMI-18 and DMI-10 Against the Combined Criteria of Clinical Judgment and CIDI Diagnoses

Test	Area Under Curve (AUC)		Sensitivity		Specificity		% Correct Classification	Positive Predictive Value		Negative Predictive Value	
	AUC	95% CI	%	95% CI	%	95% CI		%	95% CI	%	95% CI
Including Minor Depression diagnoses as a Case											
DMI-10 (≥6)	0.80	0.73–0.87	77.8	68.0–88.1	72.2	67.3–77.1	73.3	40.2	31.9–49.0	93.1	88.8–95.9
DMI-18 (≥14)	0.81	0.75–0.88	74.6	63.9–85.3	80.2	75.9–84.5	79.1	47.4	37.9–57.2	93.0	88.9–95.6
Excluding Minor Depression diagnoses as a Case											
DMI-10 (≥6)	0.80	0.71–0.88	80.0	68.3–91.7	69.7	64.7–74.7	71.7	30.0	22.5–38.7	95.6	91.8–97.6
DMI-18 (≥14)	0.80	0.72–0.88	75.6	63.1–88.1	77.3	72.7–81.9	77.0	35.1	26.3–45.0	95.1	91.5–97.2

Note: DMI: Depression in the Medically Ill; CI: confidence interval.

construct validity was reflected in high internal consistency scores, and the convergence/divergence of both measures with several psychological, social, and physical constructs in the predicted direction and magnitude. The significant correlations found between the DMI-18 and DMI-10 and anxiety scores were consistent with the moderate positive correlations reported in the literature.[28,29] Likewise, the extent of convergence with the social support measure was in keeping with the low significant-negative correlations reported for this social support scale with other depression measures;[20,30] and, although DMI-18 and DMI-10 scores did converge significantly with patients' subjective appraisal of their illness's consequences, this correlation was slightly weaker (although in the same direction) than previous reports of correlations between this measure and other depression measures.[31] Finally, the DMI-18 and DMI-10 demonstrated divergent validity with all objective measures of cardiac disease severity. Although cardiac disease severity is difficult to quantify, and all measures are imperfect, this is consistent with results reported by other researchers, who have found no relationship between depression scores and measures of disease severity in the cardiac population.[22–26]

With regard to criterion validity, when tested against our "gold standard" of clinical judgment combined with semistructured DSM-IV interview, both measures displayed good sensitivity and specificity at their optimal cutoff points. Optimal cutoff points of ≥14 and ≥6 for the DMI-18 and DMI-10 were constant, regardless of whether the diagnosis of minor depression was included as criterion for a "case" of depression. It seems contrary to clinical intuition that the optimal cutoffs remain the same regardless of whether minor depression is part of the case criterion for classification. Minor depression is differentiated from major depression in DSM-IV on the basis of a required number of symptoms. Whereas DSM-IV requires five or more symptoms for a diagnosis of major depressive episode, those with minor depression may experience between two and four of the same symptoms. The most likely explanation of this may be that a pencil-and-paper test cannot achieve the specificity required to discriminate diagnostically between minor and major depression, especially when somatic items are unavailable. Strik et al.'s results[11] support this contention. In their study, when minor depression was excluded from the criterion, the cutoff score did rise by 1–2 points for the BDI (which included somatic items); however, for the HADS Depression subscale (with no somatic items), the cutoff remained the same whether minor depression was regarded as a "case" or not.

A number of methodological limitations in this study should be noted. We cannot guarantee the representativeness of this sample because subjects were recruited nonrandomly, depending upon their availability to complete questions; ideally, the study should be repeated in a randomized sample.

Furthermore, it would have been ideal to include other pencil-and-paper depression scales in the study for the purposes of convergent validity and to enable comparisons of accuracy of classification. Because this research was part of a much larger study investigating the sequence of lifetime depression and anxiety, every effort was made to reduce redundancy in the questionnaires administered in order not to tax patients unduly. Hence, the only pencil-and-paper depression scale administered was our DMI measure, with the rationale that it could be validated against the structured clinical interview.

Finally, a limitation of any study of this nature is that it needs replication, and, in most cases, results of ROC analyses for determining cutoff points profit by being fitted to the sample at hand. Generally, when studies that test the ability of measures to classify cases at predetermined cutoff points are replicated, sensitivity and specificity estimates vary, often unfavorably. We therefore supplied confidence intervals for our sensitivity and specificity estimates so as to address this issue.

In conclusion, the DMI-18 and DMI-10 appear to be valid measures of depression in the cardiac population and may enhance the detection of depression when applied at the recommended cutoff points. The optimal cutoff points for research purposes and clinical efficacy are ≥14 for the DMI-18 and ≥6 for the DMI-10. A lower cutoff may be chosen if the measure is used for screening purposes. In line with the findings of Strik and colleagues[11] for other depression measures in the cardiac population, these cutoff points are lower than previously determined cutoff points for the DMI measures across medical specialties (i.e., DMI-18 cutoff ≥20 and DMI-10 cutoff ≥9),[20] which argues for the importance of validating pencil-and-paper measures within homogeneous medical samples. Some of the limitations of this study could be addressed by replicating this study in a randomized sample. Future research should compare the DMI-18 and DMI-10's performance with other pencil-and-paper depression measures in cardiac populations.

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APPENDIX 1. The Depression in the Medically Ill (DMI)-18 Questionnaire

Patient number ***Age*** ***Sex***

Please consider the following questions and rate how true each one is in relation to how you have been feeling lately (i.e, in the last 2 to 3 days) compared with how you usually or normally feel.

Tick (√) the most relevant option.

	Not True	*Slightly True*	*Moderately True*	*Very True*
1. Are you stewing over things?	( )	( )	( )	( )
2. Do you feel more vulnerable than usual?	( )	( )	( )	( )
3. Do you feel more ''alone'' than usual?	( )	( )	( )	( )
4. Are you more tearful than usual?	( )	( )	( )	( )
5. Do you find you don't enjoy doing the things you usually enjoy?	( )	( )	( )	( )
6. Do you feel gloomy about things?	( )	( )	( )	( )
7. Have you been feeling bad about yourself?	( )	( )	( )	( )
8. Do you feel more insecure than usual?	( )	( )	( )	( )
9. Are you being self-critical and hard on yourself?	( )	( )	( )	( )
10. Do you feel demoralized (i.e., disheartened)?	( )	( )	( )	( )
11. Are you feeling guilty about things in your life?	( )	( )	( )	( )
12. Do you feel as if you have lost your core and essence?	( )	( )	( )	( )
13. Are you feeling depressed?	( )	( )	( )	( )
14. Do you feel less worthwhile?	( )	( )	( )	( )
15. Do you feel hopeless or helpless?	( )	( )	( )	( )
16. Do you feel more distant from other people?	( )	( )	( )	( )
17. Have you lost interest in your usual activities?	( )	( )	( )	( )
18. Do you find that nothing seems to be able to cheer you up?	( )	( )	( )	( )

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