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Psychometric evaluation of the Hospital Anxiety and Depression Scale 3 months after acute lung injury

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Abstract

Purpose—To conduct a psychometric evaluation of the Hospital Anxiety and Depression Scale (HADS) and to evaluate associations of 2 measures of psychological distress with the HADS Anxiety (HADS-A) and HADS Depression (HADS-D) subscales in acute lung injury (ALI) survivors.

Materials and Methods—We used 3-month post-ALI follow-up data from 151 participants in a multisite prospective cohort study to evaluate the internal consistency and structure of the HADS subscales and items, respectively. We used Spearman ρ correlations and other statistics to relate the 3-level version of the EuroQol-5D (EQ-5D-3L) anxiety/depression item and Medical Outcomes Study Short Form-36 (SF-36) “mental health”-related domains to the HADS subscales.

Results—Internal consistency was good for each of the HADS subscales (α .70). Exploratory factor analysis revealed a 2-factor structure (anxiety and depression). The EQ-5D-3L item and the SF-36 mental health-related domain scores were associated with HADS-A (ρ = 0.54 and – 0.48 to – 0.70, respectively) and HADS-D (ρ = 0.41 and –0.48 to –0.52, respectively) scores (all P < .01).

The relationship between the SF-36 mental health domain score and the HADS-A subscale score was particularly strong ($\rho = -0.70$, $P < .01$).

Conclusions—When evaluated in ALI survivors, the HADS has good internal consistency and a 2-factor structure. The HADS subscales were substantially correlated with the EQ-5D-3L anxiety/depression item and SF-36 mental health-related domain scores, suggesting convergent validity for these measures of psychological distress in ALI survivors.

Keywords

Acute lung injury; Anxiety; Depression; Critical care; Intensive care unit; Psychometrics

1. Introduction

Survivors of critical illnesses, especially acute lung injury (ALI), frequently have substantial psychological distress, including clinically significant symptoms of anxiety and depression, with associated decrements in functioning and quality of life [1–8]. Thus, it is important to ensure that reliable and valid measures of psychological distress are available for this population.

One of the most widely used measures of anxiety and depressive symptoms in general medical settings, the Hospital Anxiety and Depression Scale (HADS) [9–12], is also used commonly in critical illness survivors [2,5–7,12]. The HADS is validated for assessing general anxiety and depressive symptoms in a wide variety of general medical patients [11–19]; however, there has been limited psychometric evaluation of the HADS in critical illness survivors. In general medical samples, the number of factors supported in analyses of the HADS items has varied from 1 [17] to the more familiar 2 [11,13,14,16,20,21] or even 3 [15]. Thus, it is relevant to determine whether the constructs measured using the HADS (ie, anxiety and depressive symptoms) are identifiable (at least partially separable) in ALI survivors. In addition, it is important to understand how the HADS subscales relate to other commonly used measures of psychological distress in this population, to provide information to clinicians and researchers who want to know the extent to which results from different instruments are comparable.

In the current study, we focused on survivors of ALI, an archetypal critical illness [22]. We hypothesized that (1) the HADS items would cohere into 2 related factors (anxiety and depressive symptoms) and (2) that there would be at least moderate associations of the HADS sub-scales with the 3-level version of the EuroQol-5D (EQ-5D-3L) anxiety/depression item and the Medical Outcomes Study Short Form-36 (SF-36) mental health-related domains.

2. Materials and methods

2.1. Study design and patient sample

This psychometric analysis was conducted as part of a multisite prospective cohort study. A total of 520 participants with ALI were recruited from 13 intensive care units (ICUs) at 4 hospitals in Baltimore, MD. Institutional review board approval was obtained at all

participating sites, with a waiver of informed consent granted for abstraction of preexisting data from the medical record. Written informed consent was obtained from survivors after they regained decision-making capacity [23] or from a proxy if the patient remained incapable. Of the 520 participants enrolled, 284 (55%) survived to hospital discharge [24]. Of those 284 survivors, 38 (13%) died after discharge, 37 (13%) declined consent, and 13 (<5%) were lost to follow-up, leaving 196 consenting survivors, 151 (77%) of whom had completed all measures of interest at 3-month follow-up (Fig. 1). Of the 196 consenting survivors at 3-month follow-up, there were no differences in age, sex, or race distributions between the 151 participants who completed all measures of interest and the 45 who did not.

Participants in this prospective cohort study were consecutive, mechanically ventilated adults with ALI [25] enrolled between October 2004 and October 2007. Patients in ICUs specializing in neurologic conditions and ALI patients with primary neurologic disease and/or brain trauma were not eligible for enrollment. In addition, the following were key exclusion criteria: (1) more than 5 days of mechanical ventilation during hospitalization prior to enrollment, (2) preexisting ALI for more than 24 hours before transfer to a study ICU, (3) preexisting illness with a life expectancy less than 6 months, (4) a limitation in use of life support (other than a sole “no cardiopulmonary resuscitation” order) at the time of enrollment, (5) prior lung resection, (6) preexisting cognitive impairment or communication/language barriers, and (7) no fixed address for follow-up purposes (ie, homelessness).

2.2. Measures

All outcome assessments were performed by research assistants at 3-month post-ALI follow-up. Anxiety and depressive symptoms were evaluated using the HADS (14 items, 2 subscales; Table 1). In addition, we evaluated an item from the EQ-5D-3L that assesses symptoms of anxiety/depression [26]. The EQ-5D-3L uses a descriptive system that includes 3 response options (ie, no problems, moderate problems, or extreme problems; Table 1). Finally, we also included data from the version 2 of SF-36 quality of life instrument [27]. The SF-36 has 8 domains; in the current study, we evaluated norm-based scores for 4 domains related to mental health (vitality, social functioning, role emotional, and mental health). Each domain has a score range of 0 to 100 (general population mean = 50; SD = 10), with higher scores indicating better quality of life (Table 1).

2.3. Statistical analyses

We evaluated the internal consistency reliability of the anxiety and depression subscales of the HADS with Cronbach α coefficient. We performed exploratory (principal components) factor analysis (PCA) with all 14 HADS items to determine whether a 2-factor structure is evident in ALI survivors, as observed in other medical populations. Because anxiety and depressive symptoms should be correlated, we performed an oblimin rotation. We then assessed the convergent validity of the EQ-5D-3L anxiety/depression item and the 4 SF-36 domains as measures of psychological distress. Because the EQ-5D-3L item and the HADS subscales were non-normally distributed, we calculated Spearman ρ correlations. We considered correlations with absolute values: <0.30, weak; between 0.30 and 0.49, moderate; and 0.50, strong [28]. We used the κ statistic as a secondary method to assess agreement between the measures (convergent validity). κ Scores were qualitatively

interpreted as follows: <0.00, poor; 0.00-0.20, slight; 0.21 to 0.40, fair; 0.41 to 0.60, moderate; 0.61 to 0.80, substantial; and 0.81, outstanding agreement [29]. Because the κ statistic is used for binary outcomes (eg, in this case, a HADS Anxiety [HADS-A] score ≥ 8 or a HADS Depression [HADS-D] score ≥ 8), we used varying thresholds for the EQ-5D-3L anxiety/depression item and the SF-36 mental health-related domains. We also conducted a receiver operating characteristics (ROC) analysis and calculated the area under the ROC curve (AUROC), which provides a composite estimate of a measure's discriminatory power across thresholds (with varying sensitivities and specificities); a value of 0.5 indicates no discriminatory power, and a value of 1.0 indicates perfect discrimination [30,31]. AUROC values lower than 0.75 are typically considered of limited utility to discriminate a criterion variable (in this case, a HADS-A score ≥ 8 or a HADS-D score ≥ 8), and values higher than 0.96 are considered very high [32].

3. Results

Among the 151 participants, the median (interquartile range) age was 49 (40-57) years, with 58% male, 60% white, and 25% with a psychiatric history and 46% with a history of drug/alcohol abuse based on existing medical records (Table 2). In these participants, 38% and 26% endorsed clinically significant anxiety and depressive symptoms, respectively (ie, HADS-A ≥ 8 or HADS-D ≥ 8).

The internal consistency (α) for each of the HADS subscales was good (HADS-A = .79 and HADS-D = .70). The HADS-A and HADS-D subscale scores were relatively highly correlated (Spearman $\rho = 0.58$). We initially performed a PCA without defining the number of expected factors, and the scree plot suggested a 2- to 3-factor solution, with 3 factors having eigenvalues greater than 1, explaining 53% of the variance. In the 3-factor solution, only 1 item (Q11 "I feel restless, as if I have to be on the move") loaded onto the third factor; however, when only 2 factors were extracted, this item loaded onto the second (ie anxiety) factor as expected. In addition, parallel analysis results suggested that only 2 factors should be extracted (ie, only 2 eigenvalues were significantly greater than expected based on the number of participants and items in our study) [33]. Thus, we next performed PCA with the number of factors limited to 2. The results were similar to those in other general medical populations [11,13,14,16,20,21]; the 2 factors comprised general anxiety and depressive symptoms (Fig. 2). All items loaded onto the expected factor, with 3 exceptions. We expected the item "I feel as if I'm slowed down" (Q8) to load onto the depression factor; however, it loaded onto the anxiety factor (0.47) without a substantial cross-loading on the depression factor. Similarly, we would have expected the item "I can sit at ease and feel relaxed" (reverse scored) to load onto the anxiety factor, but instead it loaded onto the depression factor (0.74). Finally, the item "I have lost interest in my appearance" (Q10) did not load onto either factor.

Each subscale of the HADS was moderately to strongly correlated with the EQ-5D-3L anxiety/depression item and the SF-36 domains in the expected directions (Table 3). The EQ-5D-3L anxiety/depression item was positively correlated with the HADS-A and HADS-D subscale scores ($\rho = 0.54$ and 0.41 , respectively; $P < .01$); whereas the SF-36 scores were negatively correlated with HADS-A and HADS-D subscale scores ($\rho = -0.48$ to -0.70 and

−0.48 to −0.52, respectively; $P < .01$) and the EQ-5D-3L anxiety/depression item ($\rho = -0.41$ to -0.63 ; all $P < .01$). The SF-36 mental health domain score was particularly highly correlated with the HADS-A subscale score ($\rho = -0.70$, $P < .01$).

When the EQ-5D-3L anxiety/depression item and SF-36 mental health–related domains were at thresholds to maximize κ values, levels of agreement with HADS-A and HADS-D score thresholds (≥ 8) were fair to moderate (Table 4). The only values in the moderate range were related to SF-36 role emotional and mental health score thresholds to the HADS-A score threshold.

In general, AUROC values indicated limited power of the EQ-5D-3L anxiety/depression item values and the SF-36 mental health–related domain scores to discriminate HADS-A or HADS-D score thresholds (Table 3). Discrimination tended to be slightly better for the HADS-A threshold, compared with the HADS-D threshold, and the mental health domain score was a fairly good discriminator of the HADS-A score threshold (AUROC = 0.84, $P < .01$).

4. Discussion

To our knowledge, this is the first psychometric analysis of the HADS in survivors of ALI or other critical illnesses. This analysis demonstrated that the HADS subscales have good internal consistency reliability in ALI survivors. Also, consistent with several other studies in general medical samples, we identified a 2-factor structure of the HADS items, reflecting general anxiety and depressive symptoms. Finally, the EQ-5D-3L anxiety/depression item and SF-36 mental health–related domain scores were at least moderately correlated with the HADS subscales, in the expected directions.

Nearly 40% and 30% of our sample endorsed clinically significant anxiety and depressive symptoms, respectively. These results are comparable with the point prevalences of clinically significant anxiety and depressive symptoms in ALI survivors in the extant literature [1,6,8].

In our study, the internal consistencies (α) for the HADS-A and HADS-D items were .79 and .70, respectively, both greater than the .70 criterion required to be considered reliable for group comparisons [34,35]. This finding is comparable with other studies in which Cronbach α for the HADS-A and HADS-D items has varied from .68 to .93 and from .67 to .90, respectively [10].

Similar to our study, most studies using PCA as the method of exploratory factor analysis supported a 2-factor structure in general medical samples, including hospital inpatients [21], patients with cancer [13,14], hospital outpatients [11,17], and outpatients with acquired brain injury [16]. Similar to our study, although each of these studies supported a 2-factor structure, they also identified unexpected loadings. In particular, as in our study, the item “I can sit at ease and feel relaxed” loaded on the depression factor rather than the anxiety factor [14,21]. In sum, our results support the same 2-factor dimensional structure of the HADS items as most of prior studies.

We observed substantial correlations between our measures of psychological distress: the HADS-A subscale, the HADS-D subscale, the EQ-5D-3L anxiety/depression item, and the SF-36 mental health-related domains. Thus, there was evidence of convergent validity across measures of psychological distress. However, taken together, our correlations, κ values, and ROC results suggest that neither the EQ-5D-3L anxiety/depression item nor the SF-36 mental health-related domains are measuring precisely the same thing as either of the HADS subscales. Although the SF-36 mental health domain was particularly strongly related to the HADS-A subscale in the current study, in another study involving a medical sample [36], this domain was strongly and approximately equally correlated with the HADS-A and HADS-D subscales. Thus, we conclude that the SF-36 mental health domain may be a particularly good measure of psychological distress, but not general anxiety or depressive symptoms in particular.

We acknowledge potential limitations of our study. First, the generalizability of our study may be limited. For example, our sample only included patients with ALI rather than other, perhaps less severe, critical illnesses, and we only included patients treated in teaching hospitals in the Baltimore area. However, the prevalences of clinically significant anxiety and depression symptoms in our study were comparable with those in other studies of ALI survivors. Second, a proportion of patients did not complete all measures of interest in the current study, so there could be selection bias; nevertheless, only 8% of the participants in our sample were unable to complete the 3-month follow-up, and only 8% of those who participated did not complete all of the measures of psychological distress. Third, although the HADS has been cross-validated with other measures designed to assess anxiety and depressive symptoms in survivors of critical illness [12], to our knowledge, it has not yet been validated against “gold standard” clinical diagnoses in this patient population. Nevertheless, in our study of ALI survivors, the HADS did demonstrate good convergent validity with other measures of psychological distress. In addition, in a number of prior studies of general medical patients, HADS-A and HADS-D subscale scores of at least 8 were sensitive and specific indicators of clinically significant anxiety and depressive syndromes, respectively [9,37–39].

5. Conclusions

In conclusion, consistent with results of studies in general medical populations, the HADS has good internal consistency and a 2-factor structure (ie, anxiety and depression) in ALI survivors. Each of the HADS subscales was correlated, in the expected directions, with the EQ-5D-3L anxiety/depression item and the 4 mental health-related domains of the SF-36, suggesting convergent validity for these measures of psychological distress.

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fig. 1.
Flow diagram of study participants.

fig. 2.

Hospital Anxiety and Depression Scale factor structure.^{a,b} Large ovals represent latent variables; straight lines represent hypothesized direct effects; rectangles represent measured variables; small ovals represent error terms; and numbers represent standardized parameter estimates. Large ovals represent latent variables; straight lines represent hypothesized direct effects; rectangles represent measured variables; small ovals represent error terms; and numbers represent standardized parameter estimates.^a There were no significant cross loadings (i.e. 0.4).^b Hospital Anxiety and Depression Scale Items: Q1=I feel tense or wound up; Q2=I still enjoy things I used to enjoy; Q3=I get sort of a frightened feeling as if something awful is about to happen; Q4=I can laugh and see the funny side of things; Q5=Worrying thoughts go through my mind; Q6=I feel cheerful; Q7=I can sit at ease and feel relaxed; Q8=I feel as if I am slowed down; Q9=I get sort of a frightened feeling like butterflies in the stomach; Q10=I have lost interest in my appearance (this item did not load onto either of the factors); Q11=I feel restless, as if I have to be on the move; Q12=I look forward with enjoyment to things; Q13=I get sudden feelings of panic; Q14=I can enjoy a good book or radio or TV program.

Table 1
Measures of psychological distress: EQ-5D-3L anxiety/depression item, SF-36 domain scores, and HADS

Measure	Items	Scales	Summary measures
EQ-5D-3L: anxiety/depression	I was [<i>not, moderately, extremely</i>] Anxious/Depressed	–	Anxious/Depressive symptoms
SF-36	Full of life	Vitality	Mental health
	Energy		
	Worn out		
	Tired		
	Social-extent	Social functioning	Mental health
	Social-time		
	Cut down time	Role emotional	Mental health
	Accomplished less		
	Less careful		
	Very nervous	Mental health	Mental health
	Down in dumps		
	Calm and peaceful		
	Downhearted and depressed		
	Happy		
HADS			
Anxiety subscale	Tense/Wound up	Anxiety	Anxiety symptoms
	Frightened feeling		
	Worrying thoughts		
	Feel relaxed		
	Butterflies in stomach		
	Feel restless		
	Feelings of panic		
	Still enjoy things	Depression	Depressive symptoms
Depression subscale	Can laugh		
	Feel cheerful		
	Feel slowed down		
	Lost interest in appearance		
	Look forward with enjoyment		
	Enjoy book, TV, radio		

Table 2
ALI survivors' demographic characteristics (n = 151)

Variable	n or median	Proportion ^a or IQR
Patient variables		
Age (y)	49	(40-57)
Male	88	(58%)
White	91	(60%)
Medical ICU	111	(73%)
BMI (kg/m ²)	28	(23-37)
More than high school education	46	(41%)
Employed	48	(42%)
Home medications		
Antipsychotics	4	(3%)
Narcotics	32	(21%)
Benzodiazepines	11	(7%)
Corticosteroids	15	(10%)
Charlson comorbidity index	1	(0-3)
Specific comorbidities		
Psychiatric history	38	(25%)
Drug/Alcohol abuse	69	(46%)
ICU-related variables		
APACHE II severity of illness	23	(19-28)
Maximum daily SOFA organ failure score	9	(7-11)
Length of ICU stay (d)	15	(9-23)
Length of hospital stay (d)	26	(16-36)

APACHE, Acute Physiology and Chronic Health Evaluation; BMI, body mass index; IQR, interquartile range; SOFA, Sequential Organ Failure Assessment.

^aProportions may not add to 100% due to rounding.

Table 3
Associations of the EQ-5D anxiety/depression item and SF-36 domain scores with HADS-A and HADS-D subscales 3 months after ALI

Measure	Spearman $\rho^{a,b}$	AUROC ^{a,b,c}
EQ-5D anxiety/depression	0.54; 0.41	0.74; 0.66
SF-36 social functioning	−0.48; −0.48	0.73; 0.73
SF-36 vitality	−0.51; −0.52	0.76; 0.75
SF-36 role emotional	−0.61; −0.49	0.79; 0.73
SF-36 mental health	−0.70; −0.51	0.84; 0.73

^aStatistics for the HADS-A subscale are listed first, followed by those for the HADS-D subscale.

^bAll $P < .005$.

^cThe criterion variables were HADS-A or HADS-D subscale scores 8.

Table 4
Psychometric properties of the EQ-5D-3L anxiety/depression item and SF-36 domain scores, with HADS-A or HADS-D subscale scores

Item/Scale score (% of sample)	HADS-A		HADS-D	
	Se	Sp	κ	κ
EQ-5D-3L anxiety/depression				
Moderate (51)	0.77	0.65	0.39	0.73
Extreme (10)	0.23	0.98	0.24	0.18
SF-36 social functioning ^a				
<50 (72)	0.93	0.40	0.28	0.90
<45 (63)	0.86	0.51	0.33	0.85
<40 (48)	0.68	0.64	0.31	0.75
<35 (37)	0.56	0.74	0.31	0.65
SF-36 vitality ^a				
<50 (64)	0.86	0.50	0.32	0.85
<45 (42)	0.67	0.73	0.39	0.70
<40 (31)	0.49	0.80	0.30	0.63
<35 (15)	0.26	0.91	0.20	0.35
SF-36 role emotional ^a				
<50 (63)	0.91	0.54	0.40	0.88
<45 (58)	0.86	0.60	0.41	0.83
<40 (46)	0.72	0.69	0.39	0.73
<35 (40)	0.68	0.78	0.46	0.65
SF-36 mental health ^a				
<50 (48)	0.82	0.72	0.52	0.73
<45 (44)	0.81	0.78	0.56	0.70
<40 (32)	0.61	0.86	0.49	0.58
<35 (17)	0.33	0.93	0.29	0.38

Se indicates sensitivity; Sp, specificity.

Bold indicates values for thresholds maximizing κ (all κ ; $P < .005$).

Age- and sex-normed general population: mean (SD), 50 (10); higher scores indicate better quality of life.

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