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Development and Psychometric Evaluation of the Self-Efficacy for Appropriate Medication Use Scale (SEAMS) in Low-Literacy Patients With Chronic Disease

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Medication nonadherence remains a significant obstacle to achieving improved health outcomes in patients with chronic disease. Self-efficacy, the confidence in one's ability to perform a given task such as taking one's medications, is an important determinant of medication adherence, indicating the need for reliable and valid tools for measuring this construct. This study sought to develop a self-efficacy scale for medication adherence in chronic disease management that can be used in patients with a broad range of literacy skills. The Self-efficacy for Appropriate Medication Use (SEAMS) was developed by a multidisciplinary team with expertise in medication adherence and health literacy. Its psychometric properties were evaluated among 436 patients with coronary heart disease and other comorbid conditions. Reliability was evaluated by measuring internal consistency and test-retest reliability. Principal component factor analysis was performed to evaluate the validity of the SEAMS. Reliability and validity analyses were also performed separately among patients with low and higher literacy levels. The final 13-item scale had good internal consistency reliability (Cronbach's $\alpha = 0.89$). A two-factor solution was found, explaining 52.3% of the scale's variance. The scale performed similarly across literacy levels. The SEAMS is a reliable and valid instrument that may provide a valuable assessment of medication self-efficacy in chronic disease management, and appears appropriate for use in patients with low literacy skills.

Keywords: self-efficacy; medication adherence; literacy; chronic disease; reliability; validity

Despite the availability of many effective drug therapies for the management of chronic diseases, patient nonadherence to prescribed medications remains a major obstacle to the therapeutic success of such drugs (Bodenheimer, Lorig, Holman, & Grumbach, 2002; Haynes et al., 2005). A recent survey of American adults revealed that in the past 12 months, 18% of respondents had failed to fill a prescription, 26% had delayed filling a prescription, 14% had taken a prescription medication in smaller doses than prescribed, and 30% had taken a prescription medication less often than prescribed (The Boston Consulting Group, 2003). Prior research has demonstrated that over a 1-year period, only 50–60% of patients are adherent with taking prescribed medications (DiMatteo, 2004; Osterberg & Blaschke, 2005). Recognizing the negative impact on patients' health of medication nonadherence is important for nurses and physicians alike to strive toward improving this crucial health behavior. This need led to the development of the Self-efficacy for Appropriate Medication Adherence Scale (SEAMS) to give nurses and physicians a tool to better understand and approach medication adherence in patients with low literacy skills.

BACKGROUND AND CONCEPTUAL FRAMEWORK

Several behavioral theories have been applied to the study of medication adherence (Leventhal & Cameron, 1987). Bandura's Social Cognitive Theory appears to offer a particularly useful framework (Bandura, 1986). Self-efficacy, the key construct in that theory, refers to the belief or confidence that one can successfully perform a specific action required to attain a desired outcome. Bandura proposed that self-efficacy is the most important prerequisite for behavior change, and it is accepted as an important aspect of disease management (Bodenheimer et al., 2002). Self-efficacy is also an important predictor of medication adherence (Burke, Dunbar-Jacob, & Hill, 1997; Molassiotis et al., 2002; Ni et al., 1999; Scherer & Bruce, 2001).

While a number of instruments to measure medication self-efficacy have been developed, many are designed for specific diseases or populations (Ogedegbe, Mancuso, Allegrante, & Charlson, 2003; Resnick, Wehren, & Orwig, 2003), and few are broadly applicable across a range of chronic diseases (Denhaerynck et al., 2003). There also has been limited testing of such scales' performance across all patient groups, and in particular among patients with limited literacy skills (Kalichman et al., 2005; Wolf, Chang, Davis, & Makoul, 2005). Approximately 90 million adult Americans have inadequate functional literacy skills (Kirsh, Jungeblut, Jenkins, & Kolstad, 1993; Kutner, Greenberg, & Baer, 2005), and some research suggests that low literacy is a risk factor for medication nonadherence (Chew, Bradley, Flum, Cornia, & Koepsell, 2004; Kalichman, Ramachandran, & Catz, 1999).

When using self-report scales to measure adherence, self-efficacy, and related constructs, it is important to ensure that such instruments perform well across various levels of patient literacy (Wolf, Bennett, Davis, Marin, & Arnold, 2005; Wolf, Chang, et al., 2005). Low-literacy individuals may have difficulty understanding certain items, or may interpret questions differently, potentially leading to biased responses. This article describes the development and evaluation of a medication self-efficacy scale intended for use across a variety of chronic diseases, and its performance by level of patient literacy.

DEVELOPMENT OF THE SEAMS

Procedures for Item Development and Description of the Instrument

In early 2004, we reviewed the medical and nursing literature to identify scales pertaining to medication self-efficacy. We sought an instrument or component items with simple wording that would be appropriate for use in a low-literacy population. Generalizability across medical conditions and lifestyles was also desired (e.g., a question referring to the patient's behavior while at work or going out to parties might not apply to a retired or disabled patient). Because no suitable instrument could be located, questions were selected from multiple instruments, with priority given to items that performed well in published psychometric analyses as to create a balance across a range of situations (Denhaerynck et al., 2003; Ogedegbe et al., 2003; Resnick et al., 2003). We reviewed a content map of the selected questions and generated a pool of new items to fill any gaps, particularly in areas of medication use that might be more challenging for low-literacy patients.

A multidisciplinary team with expertise in medicine, medication use, psychology, health education, and literacy discussed the resulting set of questions and assembled the initial instrument. Questions from the literature were rephrased as needed to simplify their wording or broaden their applicability beyond a single medical condition.

Approximately 10 patients completed cognitive interviews, which are helpful in evaluating the thought processes used to interpret and formulate answers to the items in question. Patients also suggested changes in the wording of items at this time. Their comments were incorporated in the final revisions of the SEAMS, a 21-item instrument.

Administration and Scoring of the Instrument

A three-point response scale was used because scales with broad response options have not been shown to be superior (Smith, Wakely, de Kruif, & Swartz, 2003). Patients were asked to indicate, under a number of different circumstances, their level of confidence about taking medications correctly (1 = not confident, 2 = somewhat confident, and 3 = very confident). The potential score for the 21-item scale ranged from 21 to 63. Higher scores indicated higher levels of self-efficacy for medication adherence.

The resulting self-efficacy scale was then administered orally as part of the enrollment interview for a randomized controlled trial—the Improving Medication Adherence Through Graphically Enhanced Interventions in Coronary Heart Disease (IMAGE-CHD) study.

METHODS

This investigation took place in the primary care clinics at Grady Memorial Hospital, an urban teaching hospital serving an indigent minority population in Atlanta, Georgia.

Sample Recruitment and Data Collection Procedures

From March 30, 2004, to March 7, 2005, 970 consecutive patients with documented coronary heart disease (CHD) who presented to the clinic were recruited for the parent study. Patients were ineligible if they did not manage their own medications, had no mailing address or telephone number, were already receiving an intervention similar to the one being tested in the clinical trial (an illustrated medication schedule), routinely filled prescriptions outside of the hospital's pharmacy system, were unable to communicate in English, were in police custody, or had visual acuity worse than 20/60. Patients with a serious psychiatric illness (schizophrenia, schizoaffective disorder, or bipolar disorder), overt delirium, or severe dementia were also excluded. Enrollment took place on the day of the clinic visit. Consenting patients completed a baseline questionnaire that included demographic information and the SEAMS. To facilitate comprehension and reduce the effect of literacy on questionnaire administration, an interviewer read all questions aloud.

For each set of items, the interviewer placed a printed response scale in front of the patient, oriented the patient to the response choices, and allowed the patient to indicate a response verbally or by pointing to the desired choice.

Upon completion of the questionnaire, patients were compensated $5 and randomized to one of four groups—intervention A, intervention B, interventions A and B, or usual care. Patients completed an in-person follow-up interview, which included the SEAMS, approximately 3 months after enrollment. Blood pressure measurements (all patients) and blood glucose values (diabetics only) for the date of enrollment were abstracted from patients' charts.

The study materials and protocol were approved by the Emory Institutional Review Board and Grady Research Oversight Committee. Statistical analyses were performed with SPSS (2004) version 13.0 for Windows.

Study Measures

In addition to the SEAMS, participants in the study were administered Morisky's self-report measure of adherence (Morisky, Green, & Levine, 1986), and the Rapid Estimate of Adult Literacy in Medicine (REALM; Davis et al., 1991; Davis, Kennen, Gazmararian, & Williams, 2005). Morisky's self-report measure is a reliable and valid index of four yes/no questions that has been used in various populations. Cronbach's alpha for this scale is .61, and it has demonstrated concurrent and predictive validity with blood pressure levels (Morisky et al., 1986).

Literacy was measured with the REALM, the most widely used measure of literacy in the health care setting (Davis et al., 1991, 2005). The REALM is a 66-item word recognition and pronunciation test using common terms from the health care setting. Scores on the REALM were dichotomized to indicate inadequate (raw score 0–44, ≤ 6th grade reading level) or higher (marginal/adequate, raw score 45–66, ≥ 7th grade reading level) literacy skills. This measure has demonstrated excellent test-retest reliability of .99 and correlation with several widely accepted standardized tests of literacy including the Wide Range Achievement Test-Revised (WRAT-R; Davis et al., 1991).

Approaches to Reliability and Validity Assessment and Scale Refinement

Internal Consistency Reliability. Internal consistency of the SEAMS was determined by computing Cronbach's alpha, evaluating the item-total correlation coefficient for the scale items, and observing the interitem correlation matrix. Cronbach's alpha is a measure to describe the interrelatedness among the items of a scale to determine how well the items measure the same construct (DeVellis, 1991). Nunnally and Bernstein note that an alpha coefficient ≥ 0.7 suggests adequate reliability of a scale (Nunnally & Bernstein, 1994). Item-total correlation coefficients provide an indication of how closely each item is associated with the total scale. Generally, items showing a correlation ≤ 0.3 to the total scale are considered conceptually different, or weak items. Finally, the correlation matrix of the items was reviewed, which gave insight into how interrelated the items of the scale were. Nunnally and Bernstein suggest that values between .2 and .8 are ideal, with correlations less than .2 generally indicating that an item has a weak relationship to the other items. Correlations greater than .80 generally indicate the items are too closely related, or redundant (Nunnally & Bernstein, 1994).

Test-Retest Reliability. A second approach used in our study to assess the reliability of the scale was to determine the stability of responses over time. Test-retest reliability was examined by computing a correlation coefficient between the baseline and 3-month follow-up self-efficacy ratings of 96 patients in the control group of the randomized trial. Correlations of 0.9 or greater are considered excellent when measuring the stability of an instrument over time, while correlations ranging from 0.7 to 0.9 are very good.

Factor Analysis. Principal component exploratory factor analysis was conducted to assess the internal structure of the SEAMS. This technique is used to reduce a set of observed items to a smaller set of variables that reflects the interrelationships among the observed variables (DeVellis, 1991). For the purposes of our study, we used the technique to reveal the dimensions of self-efficacy that were measured by the SEAMS. We then used the technique to further refine the 21-item scale.

The first step in the factor analysis was to observe the correlation matrix of all 21 items and calculate the mean interitem correlation to identify the strengths of association between the items. This was necessary to gain an initial understanding of whether the scale would adequately factor in subsequent analyses. To determine the initial number of factors in the instrument, eigenvalues greater than one were used. Scree plots were also examined. As the items were sorted into factors, we evaluated the sets of items generated by the Varimax rotated component matrix to determine whether they fit into conceptually sound dimensions. Items demonstrating a loading of 0.4 or greater were considered to adequately measure a factor; items that loaded 0.4 or greater onto more than one factor were considered individually and were grouped according to interpretability rather than the highest loading.

Final Scale Development. To establish the final scale, results of both the factor analysis and internal consistency evaluation were considered. Items were eliminated if they did not load on a well-defined dimension of the medication self-efficacy construct and were difficult to interpret. Further principal component exploratory factor analysis was conducted on the remaining items to evaluate the dimensions of the reduced scale.

Internal consistency analysis was then performed on the reduced set of items, and individually on the items of each newly established factor. Items were retained if the item-total correlation coefficient was > 0.3 and Cronbach's alpha remained > 0.7. The items whose removal from the overall scale indicated that Cronbach's alpha would increase were individually reviewed to determine whether their inclusion in the scale was justified clinically.

Given our interest in developing a scale that would be of clinical utility in a low-literacy population, we completed our psychometric analysis by conducting internal consistency analysis and factor analysis separately in patients with inadequate literacy and higher (marginal/adequate) literacy skills. We hypothesized that scale properties would remain relatively consistent across the two patient groups, given the attention to simple wording when composing individual items.

Criterion-Related Validity. Once the final scale was established, we analyzed criterion-related validity by comparing composite self-efficacy scores against the Morisky adherence scale using Spearman's rho (Morisky et al., 1986). We hypothesized that medication self-efficacy and self-reported adherence would be positively correlated. To further establish criterion-related validity, we compared self-efficacy scores among patients with controlled and uncontrolled blood pressure, using data abstracted from patient charts. According to national guidelines, controlled blood pressure was defined as a level $< 140/90$, or $< 130/80$ among patients with diabetes (Chobanian et al., 2003). We hypothesized that those with controlled blood pressure would have higher levels of medication self-efficacy. Finally, among patients with diabetes, we compared mean fingerstick glucose levels among patients with high and low self-efficacy, hypothesizing that glucose levels would be lower among patients with high medication self-efficacy. For this analysis, low self-efficacy was defined as a score less than or equal to the scale median, and high self-efficacy was defined as a score above the median.

RESULTS

Subject Characteristics

The randomized trial included 436 patients, all of whom completed the SEAMS during the baseline interview. Approximately half (55.7%) were women, and the mean age was

TABLE 1. Characteristics of the Study Population (*N* = 436)

Characteristic	Overall
Age (yrs), mean ± *SD*	63.8 ± 10.4
Gender, *n* (%)	
Male	193 (44.3)
Female	243 (55.7)
Race, *n* (%)	
White	31 (7.1)
African American (non-Hispanic)	397 (91.1)
Asian	3 (0.7)
Hispanic/Latino	4 (0.9)
Other	1 (0.2)
Marital status, *n* (%)	
Married	65 (14.9)
Separated	58 (13.3)
Divorced	114 (26.1)
Widowed	124 (28.4)
Single/never married	73 (16.7)
Living with someone	2 (0.5)
Annual income, mean ± *SD* [a]	$10,401.61 ± $4261.63
Employment, *n* (%)	
Unemployed	68 (15.6)
Full-time	9 (2.1)
Part-time	24 (5.5)
Other (retired, disabled)	335 (76.8)
Years of education, mean ± *SD*	10.9 ± 3.1
Literacy skills, *n* (%)	
Inadequate[b]	197 (45.2)
Higher	239 (54.8)
MMSE, mean ± *SD*	24.7 ± 3.2

Note. MMSE = Mini Mental State Examination.

[a]Income available for 334 participants. [b]Inadequate: ≤ 6th grade reading level; Higher: ≥ 7th grade reading level.

63.8 years (*SD* = 10.4). The population was predominantly African American (91.1%). Approximately 53% of patients had completed high school, and 45% had inadequate literacy skills (see Table 1).

Participants frequently had multiple chronic comorbid illnesses, including hypertension (99%), hypercholesterolemia (87%), and diabetes (45%). Among patients with hypertension, the mean systolic and diastolic blood pressure were 136 (*SD* = 21) and 75 (*SD* = 12.5), respectively. Approximately half (46%) were considered to have adequately controlled blood pressure. Among patients with diabetes, the mean glucose level was 173 (*SD* = 82). Patients were taking a mean of nine prescription medications (*SD* = 3).

Reliability

Internal Consistency Reliability. Mean responses on each item of the original 21-item SEAMS ranged from 1.91 to 2.91 (Table 2). Item-total correlation coefficients revealed moderate to strong correlations of all 21 items to the total scale, ranging from 0.36 to 0.67. The mean interitem correlation of the items was .32, and interitem correlations among the 21 scale items ranged from 0.08 to 0.71, indicating that no items were exceedingly redundant. Though some of the interitem correlations were below the recommended criterion of 0.2, the bulk of the interitem correlations were above this value and were within the recommended range of 0.2–0.8. Cronbach's alpha for the overall scale was 0.90, and the analysis revealed that Cronbach's alpha would not have increased with the deletion of any items.

Test-Retest Reliability. Based on responses from 96 control subjects who completed the follow-up interview, test-retest reliability of the 21-item scale was moderate (Spearman's $\rho = 0.62$, $p = 0.0001$).

Validity

Factor Analysis. For the original scale, the principal component exploratory factor analysis revealed a four-factor solution based on eigenvalues >1 (Table 3). The scree plot also identified a four-factor solution. Factor 1 accounted for 36.05% of the variance explained, while all four factors together accounted for 54.61% of the variance. Four items (numbers 3, 4, 13, and 19) loaded >0.4 on more than one factor. Fourteen of the items loaded onto the first two factors, while the remaining six items loaded onto the remaining two factors. It was difficult to find an underlying dimension of self-efficacy for each of the four factors, and thus the factors were not named at this point.

Final Scale Development. Given that the SEAMS performed well in the reliability analysis but did not factor into any identifiable domains, we returned to the items to try a more parsimonious approach. We tested a reduced set of items that excluded general self-efficacy questions (items 1 and 2) as well as the items that shared a different question format (items 17–21). Item 14, which had the lowest item-total correlation initially, had low interitem correlations, and also performed poorly in our further subgroup analysis by literacy, was deleted as well.

Factor analysis of the remaining 13 items resulted in the emergence of a two-factor solution, with items 3, 4, 5, 6, 8, 9, and 10 loading onto factor 1 and items 7, 11, 12, 13, 15, and 16 loading onto factor 2 (Table 4). These factors were felt to represent two clear dimensions—self-efficacy for taking medications under difficult circumstances (factor 1) and self-efficacy

TABLE 2. Item Analysis of Original and Reduced Scale

	Original 21-Item Scale			Reduced 13-Item Scale		
Items	Mean ± *SD*	Item-Total Correlation Coefficient	Cronbach's α if Item Is Deleted	Mean ± *SD*	Item-Total Correlation Coefficient	Cronbach's α if Item Is Deleted
1. How confident are you that you will keep all your medical appointments as scheduled?	2.71 ± 0.53	0.39	0.90			
2. How confident are you that you will be able to take all or most of your medicines as directed? How confident are you that you can take your medicines correctly. . . .	2.78 ± 0.47	0.56	0.90			
3. When you take several different medicines each day?	2.71 ± 0.55	0.61	0.90	2.71 ± 0.55	0.60	0.88
4. When you take medicines more than once a day?	2.59 ± 0.64	0.58	0.90	2.60 ± 0.64	0.59	0.88
5. When you are away from home?	2.51 ± 0.69	0.67	0.90	2.51 ± 0.69	0.65	0.87
6. When you have a busy day planned?	2.56 ± 0.65	0.66	0.90	2.56 ± 0.65	0.64	0.88
7. When they cause some side effects?	1.91 ± 0.82	0.45	0.90	1.92 ± 0.82	0.49	0.88

8. When no one reminds you to take the medicine?	2.75 ± 0.50	0.54	0.90	2.75 ± 0.50	0.48	0.88
9. When the schedule to take the medicine is not convenient?	2.34 ± 0.71	0.59	0.90	2.34 ± 0.71	0.62	0.88
10. When your normal routine gets messed up?	2.25 ± 0.73	0.62	0.90	2.25 ± 0.73	0.64	0.87
11. When you are not sure how to take the medicine?	2.11 ± 0.85	0.62	0.90	2.11 ± 0.85	0.65	0.87
12. When you are not sure what time of the day to take your medicine?	2.24 ± 0.80	0.58	0.90	2.24 ± 0.80	0.60	0.88
13. When you are feeling sick (like having a cold or the flu)?	2.42 ± 0.74	0.56	0.90	2.42 ± 0.73	0.54	0.88
14. When you are feeling fine?	2.91 ± 0.33	0.36	0.90			
15. When you get a refill of your old medicines and some of the pills look different than usual?	2.29 ± 0.79	0.51	0.90	2.28 ± 0.78	0.52	0.88
16. When a doctor changes your medicines? How confident are you that you can carry out the following tasks. . . .	2.44 ± 0.71	0.52	0.90	2.44 ± 0.70	0.51	0.88

Table 2. continued

Items	Original 21-Item Scale			Reduced 13-Item Scale		
	Mean ± *SD*	Item-Total Correlation Coefficient	Cronbach's α if Item Is Deleted	Mean ± *SD*	Item-Total Correlation Coefficient	Cronbach's α if Item Is Deleted
17. Get refills for your medicines before you run out?	2.49 ± 0.74	0.39	0.90			
18. Fill your prescriptions whatever they cost?	2.15 ± 0.87	0.47	0.90			
19. Make taking your medicines part of your routine?	2.80 ± 0.45	0.55	0.90			
20. Always remember to take your medicines?	2.74 ± 0.50	0.55	0.90			
21. Take your medicines for the rest of your life?	2.56 ± 0.68	0.49	0.90			

Note. Items for the reduced 13-item scale are shaded in gray.

TABLE 3. Factor Analysis for Original Scale (Varimax Rotated Component Matrix)

Items	Factor 1 Rotated Component Loading	Factor 2 Rotated Component Loading	Factor 3 Rotated Component Loading	Factor 4 Rotated Component Loading
Eigenvalue	7.57	1.63	1.16	1.10
% Variance explained	36.05	7.78	5.54	5.24
11. When you are not sure how to take the medicine?	**0.70**	−0.03	0.28	0.29
12. When you are not sure what time of the day to take your medicine?	**0.70**	−0.10	0.35	0.21
9. When the schedule to take the medicine is not convenient?	**0.66**	0.30	−0.01	0.17
10. When your normal routine gets messed up?	**0.62**	0.31	0.08	0.21
5. When you are away from home?	**0.62**	0.36	0.30	0.06
4. When you take medicines more than once a day?	**0.59**	**0.43**	0.05	0.06
6. When you have a busy day planned?	**0.55**	**0.40**	0.29	0.11
7. When they cause some side effects?	**0.50**	0.07	−0.09	**0.43**
13. When you are feeling sick (like having a cold or the flu)?	**0.43**	0.07	**0.40**	0.34
8. When no one reminds you to take the medicine?	0.28	**0.68**	0.15	0.06
2. How confident are you that you will be able to take all or most of your medicines as directed?	0.18	**0.64**	0.29	0.17
14. When you are feeling fine?	0.02	**0.62**	0.07	0.14
20. Always remember to take your medicines?	0.17	**0.59**	0.29	0.31
3. When you take several different medicines each day?	**0.50**	**0.58**	0.06	0.09
19. Make taking your medicines part of your routine?	0.15	**0.54**	**0.47**	0.12
17. Get refills for your medicines before you run out?	0.01	0.28	**0.68**	0.07

Table 3. continued

Items	Factor 1 Rotated Component Loading	Factor 2 Rotated Component Loading	Factor 3 Rotated Component Loading	Factor 4 Rotated Component Loading
1. How confident are you that you will keep all your medical appointments as scheduled?	0.22	0.14	**0.64**	−0.08
18. Fill your prescriptions whatever they cost?	0.18	0.13	**0.51**	0.33
16. When a doctor changes your medicines?	0.20	0.20	0.06	**0.77**
15. When you get a refill of your old medicines and some of the pills look different than usual?	0.31	0.13	0.04	**0.69**
21. Take your medicines for the rest of your life?	0.05	0.29	0.36	**0.54**

Note. Those items in bold text are those that meet the .40 criterion for loading onto each factor.

for continuing to take medications when circumstances surrounding medication-taking are uncertain (factor 2). Item 10, which loaded > 0.4 onto both factors, was found to agree conceptually with factor 1.

Reliability analysis for the reduced 13-item scale revealed interitem correlations of 0.20 to 0.71, high item-total correlations, and a Cronbach's alpha of 0.89 (Table 2). For the two subscales, taking medications under difficult circumstances and under conditions of uncertainty, Cronbach's alpha was 0.86 and 0.79, respectively. The analysis did not indicate that Cronbach's alpha would increase substantially for the 13-item scale or either subscale with the further deletion of items. The mean interitem correlations in the 13-item scale and two subscales were 0.38, 0.46, and 0.39, respectively. Test-retest reliability of the 13-item scale was adequate (Spearman's $\rho = 0.57$, $p = .0001$).

Criterion-Related Validity. As anticipated, self-efficacy as measured by the 13-item scale was strongly correlated with medication adherence as assessed by the Morisky scale (Spearman's $\rho = 0.51$, $p = .0001$), providing evidence for the criterion-related validity of the self-efficacy scale.

Patients with controlled hypertension did not have significantly higher self-efficacy scores than those with uncontrolled blood pressure. Similarly, there was no statistically significant difference in blood glucose levels comparing participants with high self-efficacy versus those with low self-efficacy.

Scale Performance by Literacy Level. Among patients with inadequate literacy skills ($n = 197$), Cronbach's alpha for the 13-item scale was 0.89, with a mean interitem corre lation of 0.40. No poorly performing items were identified, such that their deletion would increase Cronbach's alpha. Principal component factor analysis revealed a two-factor

TABLE 4. Factor Analysis for Reduced Scale (Varimax Rotated Component Matrix)

Items	Factor 1 Rotated Component Loading	Factor 2 Rotated Component Loading
Eigenvalue	5.62	1.18
% Variance explained	43.25	9.07
How confident are you that you can take your medicines correctly. . . .		
3. When you take several different medicines each day?	**0.73**	0.22
6. When you have a busy day planned?	**0.72**	0.29
5. When you are away from home?	**0.71**	0.32
8. When no one reminds you to take the medicine?	**0.70**	0.08
4. When you take medicines more than once a day?	**0.69**	0.24
9. When the schedule to take the medicine is not convenient?	**0.62**	0.36
10. When your normal routine gets messed up?	**0.59**	**0.41**
15. When you get a refill of your old medicines and some of the pills look different than usual?	0.12	**0.74**
11. When you are not sure how to take the medicine?	0.30	**0.73**
12. When you are not sure what time of the day to take your medicine?	0.26	**0.71**
16. When a doctor changes your medicines?	0.18	**0.65**
7. When they cause some side effects?	0.25	**0.56**
13. When you are feeling sick (like having a cold or the flu)?	0.37	**0.52**

Note. Those items in bold text are those that meet the .40 criterion for loading onto each factor.

solution with item correlations ranging from 0.23 to 0.70. The eigenvalues for the two factors were 5.85 and 1.06, accounting for 45.03% and 8.18% of the variance, respectively. Items 3, 4, 5, 6, 8, 9, 10, and 13 loaded onto factor 1 while items 7, 11, 12, 15 and 16 loaded onto factor 2.

In those patients with higher literacy skills (n = 239), the scale demonstrated a Cronbach's alpha of 0.88 and a mean interitem correlation of 0.36. Again, deletion of any items would not have increased Cronbach's alpha. Factor analysis revealed a two-factor solution (factor 1: items 3, 4, 5, 6, 8, and 9; factor 2: items 7, 10, 11, 12, 13, 15, and 16) with item correlations ranging from 0.15 to 0.72. The first factor had an eigenvalue of 5.41 and accounted for 41.58% of the variance; the second factor had an eigenvalue of 1.41 and accounted for 10.83% of the variance.

DISCUSSION

We developed the SEAMS, a scale to assess self-efficacy for appropriate medication use that can be used among patients with a variety of chronic diseases and across various levels of patient literacy. Psychometric analyses determined the overall scale to be reliable and valid, having a strong correlation with self-reported medication adherence.

Factor analysis of the SEAMS revealed two dimensions of medication self-efficacy. The first was self-efficacy for taking medications under difficult circumstances, such as when patients are busy, away from home, or have multiple medications to take. The second was self-efficacy for taking medications under uncertain or changing circumstances, such as when the patient is unsure about how to take the medications or changes are made to the regimen. Further study using these two dimensions of medication self-efficacy may help identify specific problem areas for patients, facilitating the ability to tailor interventions appropriately to patients needs.

While the validity of this scale is supported by its correlation with self-reported adherence, we were not able to demonstrate a statistically significant relationship with blood pressure or glycemic control. A similar scale by Odegdebe et al. for use among hypertensive patients also did not show a significant association with blood pressure control (Ogedegbe et al., 2003). We do not believe that this necessarily represents a failure of either scale, but rather an indication that other factors may also moderate the relationships among self-efficacy, adherence, and health outcomes. Moreover, patients at our study site also received an aggressive diabetes disease management intervention, which may have attenuated the effect of patient-level factors like self-efficacy on the degree of glycemic control (Ziemer et al., 2006).

The psychometric analysis by literacy level revealed good internal consistency in both patient subgroups, indicating that the scale remains reliable even among low-literacy patients. Factor analysis in each group revealed similar two factor solutions but with crossover of two items (numbers 10 and 13). The reason for these differences in item performance is unclear and will be explored in future analyses. At present, we recommend use of the overall 13-item scale, rather than its two potential subscales, when analyzing differences in self-efficacy by literacy level until further testing reveals why the two subscales had some crossover of items in the factor analysis by literacy level.

By evaluating the SEAMS performance across literacy levels, this psychometric analysis joins a small but growing number of reports that specifically considered patients' literacy skills in the design and testing of behavioral instruments (Kalichman et al., 2005;

Wolf, Bennett, et al., 2005; Wolf, Chang, et al., 2005). Given that nearly half of adult Americans have limited literacy skills (Institute of Medicine, 2004), and that low literacy can affect the interpretation of test items (Wolf, Bennett, et al., 2005), it is important that more instruments be developed and validated for use among low-literacy patients. In the wording of questions, researchers should use everyday language when possible and consider use of a formal Lexile assessment, which indicates the difficulty of text wording (Wolf, Chang, et al., 2005). Different approaches appear effective for scale administration, including the use of a short Likert response scale with supplementary visual cues (used here), a pictographic visual analogue scale (Kalichman et al., 2005), or a two-step process for presenting response options, in which patients first commit to agreeing or disagreeing and then indicate the degree of their feeling (Wolf, Chang, et al., 2005).

The availability of a medication self-efficacy scale for chronic disease has important implications for health care researchers and practitioners. Given the high prevalence of medication nonadherence in the treatment of chronic illnesses (Osterberg & Blaschke, 2005), the development of effective, conceptually based interventions to improve medication use could have both large clinical and public health impact (Haynes et al., 2005). Prior research suggests that self-efficacy is a strong predictor of treatment adherence (Burke et al., 1997; Molassiotis et al., 2002; Ni et al., 1999; Scherer & Bruce, 2001) and that it serves as a useful basis for interventions (Mahler, Kulik, & Tarazi, 1999; van Es, Nagelkerke, Colland, Scholten, & Bouter, 2001). The SEAMS offers researchers a tool to assess self-efficacy for medication use in patients with chronic diseases and with various levels of literacy. It may be helpful in identifying patients at risk for nonadherence, or in assessing the ability of an intervention to enhance patients' self-efficacy.

One limitation of this study was the measurement of follow-up SEAMS scores 3 months after the baseline assessment, due to the design of the parent study. This may have accounted for the lower-than-expected correlation between initial and follow-up self-efficacy scores. Ideally, the second administration of the scale would have taken place 2 weeks after the initial measurement. The generalizability of our results may also be limited by the predominance in our study of elderly, indigent, African American patients who take multiple medications, as well as the performance of the study at a single site.

In conclusion, the SEAMS represents a reliable and valid instrument appropriate for use among patients with a variety of chronic diseases and literacy levels. Future study of the SEAMS will include prospectively evaluating the impact of medication self-efficacy on medication adherence and a variety of health outcomes, including control of hypertension, glycemic level, and blood lipid levels. Ultimately, the results of these analyses may be used to design and deliver effective health interventions for improving medication adherence and health outcomes.

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