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Do Subjective Measures Improve the Ability to Identify Limited Health Literacy in a Clinical Setting?

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Abstract

Background: Existing health literacy assessments developed for research purposes have constraints that limit their utility for clinical practice, including time requirements and administration protocols. The Brief Health Literacy Screen (BHLS) consists of three self-administered Single Item Literacy Screener (SILS) questions and obviates these clinical barriers. We assessed whether the addition of SILS items or the BHLS improve the ability to identify limited health literacy when added to patient demographics readily available in ambulatory clinical settings reaching underserved patients.

Methods: We analyzed data from two cross-sectional convenience samples of patients from an urban academic emergency department (n=425) and a primary care clinic (n=486) in St. Louis, MO. Across samples health literacy was assessed using the Rapid Estimate of Adult Literacy in Medicine-Revised (REALM-R), Newest Vital Sign (NVS), and the BHLS. Our analytic sample consisted of 911 adult patients that were primarily female (62%), Black (66%), and had at least a high school level education (82%); 456 were randomly assigned to the estimation sample and 455 to the validation sample.

Results: The analysis showed that the best REALM-R estimation model contained age, gender, education, race, and one SILS item (difficulty understanding written information). In validation analysis this model had sensitivity=62%, specificity=81%, positive likelihood ratio (LR^+) =3.26, negative likelihood ratio (LR^-) =0.47, and 28% misclassification rate. The best NVS estimation

model contained the BHLS, age, gender, education and race; this model has sensitivity=77%, specificity=72%, LR^+ = 2.75, LR^- =0.32, and misclassification rate=25%.

Conclusions: Findings suggest that the BHLS and SILS items improve our ability to identify patients with limited health literacy compared with demographic predictors alone However, despite being easier to administer in clinical settings, subjective estimates of health literacy have misclassification rates >20% and do not replace objective measures; universal precautions should be used with all patients.

Introduction

Health literacy, often defined as the degree to which individuals can obtain, process, and understand basic health information and services needed to make appropriate health decisions[1], is a critical predictor of health knowledge, health outcomes, and health care utilization[1,2]. Limited health literacy has been associated with a higher rate of hospitalization [3–6], lower use of preventive services[5], and less effective management of chronic conditions [7]. The translation of health literacy measurement beyond the research environment to clinical settings, in order to help target potential interventions, has been hampered by tools that require administration by staff and face other barriers to completion[8–10]. For example, the S-TOFHLA is timed and can take up to 7 minutes to complete, increasing the potential for interruptions that could affect performance[11].

In considering implementation of health literacy assessments in overcrowded and understaffed medical settings, researchers must consider the trade-offs between instrument complexity, patient acceptability, and diagnostic accuracy[12,13]. If found to be brief, accurate, and reliable, health literacy screening instruments could be converted to iPad/kiosk applications that patients could complete while awaiting care, as has been done for dementia[14], vision[15], and substance abuse[16]. The Brief Health Literacy Screen (BHLS) contains three Single Item Literacy Screener (SILS) items, self-administered brief subjective questions in which patients report their perceived health literacy skills, avoiding some of the barriers presented by objective screening tools. Diagnostic accuracy and validity of the SILS relative to the Rapid Estimate of Adult Literacy in Medicine (REALM) and Newest Vital Sign (NVS) have been previously reported.[11,17–19]

In prior research, the BHLS has been validated to detect limited health literacy using the S-TOFHLA as the criterion standard in a study of 332 Caucasian veterans (AUROC 0.76 - 0.87)[18]. The BHLS was subsequently validated in a large (n=1796) Veterans Administration patient population of mostly older white males with at least a high school education. The "confident with forms" item performed the best and the ability to identify patients with limited health literacy varied based on the reference standard (AUROC 0.74 for S-TOFHLA, 0.84 for REALM). In a subsequent study, Wallace et al. [20] evaluated the three SILS using the REALM as the criterion standard in a population (n=305) consisting of predominantly white females with mean age of 49.5. "Confident with Forms" was superior to the other questions and demographic information (gender, age, race, educational attainment, health insurance). The ability to identify limited health literacy (AUROC 0.82) on REALM was similar to Chew et al. [17]

In several clinical studies, associations have found between SILS and various health outcomes[21–25]. Limited health literacy measured using SILS has been shown to be associated with discontinuation of anti-depression medication among patients with type 2 diabetes[26], perception of low coordination of care and low satisfaction among women with breast cancer[27], health care discrimination among diabetics[28], increased risk of hospital admissions[5], decreased knowledge of chronic disease among hypertensives and diabetics[3], poorer physical and mental health among older adults[29], and poorer outcomes among diabetics[21]. In addition, the BHLS has been validated for use in clinical settings when administered by nurses during patient intake[25].

However, age, race, and education, which can be readily collected in clinical settings, have been found to be significant predictors of health literacy in a systematic review of 85 studies[30]. Therefore, there is a need to examine the ability of SILS items and the BHLS in addition to demographic factors to identify patients with limited health literacy[20]. We quantitatively assessed whether the addition of each SILS item or the BHLS improve the ability to identify patients with limited health literacy compared with patient demographic information. We hypothesized that a combination of the SILS and demographic characteristics improves the ability to identify patients with limited health literacy compared with standard sociodemographic variables in clinical settings where administration of objective health literacy assessments is not feasible.

Methods

Settings and participants

We analyze data from two cross-sectional convenience samples of patients from an emergency department (ED) (n=425) and primary care clinic (n=486) affiliated with an urban academic medical center in St. Louis, MO. Using SAS statistical software half of the participants from each sample are randomly assigned to the estimation data set and the remaining observations are combined to form the validation data set.

Emergency Department

Trained research assistants recruited patients between March 1, 2011 and February 29, 2012 from an urban academic ED. Patients aged ≥ 18 years were identified for enrollment by review of the electronic medical record dashboard. Exclusion criteria included: undue patient distress as judged by the attending physician, altered mental status, aphasia, mental handicap, previously diagnosed dementia or insurmountable communication barrier as judged by family or the screener, non-English speaking, sexual assault victims, acute psychiatric illness, or corrected visual acuity worse than 20/100 using both eyes. This study was approved by the hospital Institutional Review Board. Research assistants administered health literacy assessments to all eligible and consenting patients and recorded participant responses. Demographic data elements were collected during the interview and from the electronic medical record. De-identified age, race, and gender data were recorded for patients declining to participate. 588 patients were approached, 139 (24%) refused, 9 were excluded, and 446 (76%) enrolled. Enrolled patients' age, gender, and race did not significantly differ from patients that refused to participate or from the ED patient population[11,31,32].

Primary Care Clinic

Participants were recruited between July 2013 and April 2014 from the Primary Care Clinic (PCC) of the same large urban academic medical center. Patients in the waiting rooms of the PCC were approached by trained data collectors and asked to complete a survey in English. Inclusion criteria were that participants be at least 18 years old, a patient at the PCC, and speak English. Participants were asked to complete a self-administered written questionnaire and a verbally administered survey component. The latter component assessed health literacy with

the Rapid Estimate of Adult Literacy in Medicine-Revised (REALM-R) and NVS and was administered by a trained data collector who recorded responses. All participants completed a verbal consent process and signed a written consent form before completing the survey. This study was approved by the Human Research Protection Office at Washington University School of Medicine.

Approximately 26% (n=1,111) of those approached were ineligible to participate in the study because they were not patients, did not speak English, or had previously taken the survey. Among eligible participants, 44% (n=1380) agreed to participate in the study and were consented by trained data collectors. Of the 1380 patients who were consented, 975 (71%) completed the written survey. Among those with complete written surveys, 602 (60%) completed the verbally administered component. Survey respondents were generally similar to the underlying primary care clinic patient population with respect to gender, age, and race.

For inclusion in this analysis participants must have completed all three health literacy assessments (i.e., REALM-R, NVS, BHLS) and have demographic data (age, gender, race, education). Due to the small number of patients in the "other race" category for both the ED (n=11) and PCC (n=27) we limited analysis to patients whose self-reported race was white or black and met all inclusion criteria, n=425 for ED and n=486 for PCC.

Health Literacy Assessments

Rapid Estimate of Adult Literacy in Medicine-Revised (REALM-R)

The REALM-R is a health literacy assessment (word recognition test) in which participants are asked to pronounce 11 common medical terms: “fat,” “flu,” “pill,” “allergic,” “jaundice,” “anemia,” “fatigue,” “directed,” “colitis,” “constipation,” and “osteoporosis.” The first three words are included to reduce test anxiety, and are therefore not scored as part of the REALM-R. A trained REALM-R administrator scores the pronunciation (correct/incorrect) of each of the remaining eight words, resulting in 8 possible points.[8] Using standard scoring, we dichotomized the REALM-R score into limited health literacy (scores 0-6) and adequate health literacy (scores >6)[33].

Newest Vital Sign (NVS)

The Newest Vital Sign (NVS) is a verbally administered six-item measure that asks about information contained in a standard food nutrition label which requires reading comprehension and numeracy skills [34]. Participants received a NVS score ranging from 0 to 6 based on the number of correct answers. Scores from 0-1 reflect a high likelihood of limited health literacy, 2-3 a possibility of limited health literacy and 4-6 adequate health literacy[34].

Brief Health Literacy Screen (BHLS)

Participants were administered three written SILS items, which were measured on five-point Likert scales that assess self-reported health literacy skills. “How often do you have problems learning about your medical condition because of difficulty understanding written information?” (1=“always”, 2=“often”, 3=“sometimes”, 4=“rarely”, 5= “never”). “How confident are you filling out medical forms by yourself?” (1=“not at all”, 2=“a little bit”, 3=“somewhat”, 4=“quite a bit”, 5=“extremely confident”) and “How often do you have someone help you read

hospital materials?" (1="always", 2="often", 3="sometimes", 4="rarely", 5="never"). In the estimation models, these questions were dichotomized into limited health literacy (responses <4)/adequate health literacy (responses ≥4) as individual predictors and continuously as a BHLS sum score based on prior studies.[17,18,35]

Statistical Analysis

Sample characteristics for the overall combined samples (N=911) and the estimation (n=456) and validation (n=455) samples are described in Table 1. Table 2 displays five estimation models for two validated objective health literacy measures (REALM-R, NVS). We started with a base multivariable logistic regression model consisting of patient demographic information; age (continuous), gender (female, male), race (White, Black) and education (less than high school, high school diploma or equivalent degree, more than high school). Categorical variables were modeled using indicators with male as the reference for gender, white as the reference for race, and high school (middle category) as the reference level of education. Each SILS item is examined individually by adding them one at a time to the base model; these models are compared to a model that includes the full BHLS sum score. To select a final estimation model we used three goodness of fit criteria: rescaled R-squared, Akaike Information Criterion (AIC), and Area Under the ROC Curve (AUROC). R-squared and AUROC values closer to 1 and smaller AIC values are obtained from models with better fit. Data were analyzed using SAS 9.4; statistical significance was assessed at $p<0.05$.

Based on the best estimation model we estimated the probability of limited health literacy for each participant in the validation sample. The limited health literacy cut-off was determined by the lowest misclassification rate to establish an ideal trade-off between sensitivity and specificity. We examined the discrimination (ability to distinguish patients with limited health literacy from those with adequate health literacy) of the final estimation model and the cut-off selected by examining concordance (sensitivity, specificity) using a 2x2 table, kappa statistic (and 95% confidence interval), and misclassification rate. The kappa statistic measures inter-rater agreement; we examined the agreement between the estimation models and validated objective health literacy assessments (REALM-R, NVS) for determining patients with limited health literacy[36,37]. We assess this model as a diagnostic test for limited health literacy by calculating positive and negative likelihood ratios.

Results

The analytic sample consisted of 911 patients; the majority were female (62%), Black (66%) and had at least a high school level education (83%). Patient age ranged from 18 to 94 with an average age of 49 years (St. dev=14). The majority of patients were assessed as having adequate health literacy based on the REALM-R (54%) but limited health literacy according to the NVS (63%). The majority (72%) reported "rarely" or "never" having difficulty understanding written information. More than half of the patients reported being "extremely" or "quite a bit" confident (62%) filling out medical forms. A majority (74%) stated that they "rarely" or "never" have someone help them read hospital materials. Half of this sample was randomly selected to the estimation sample (n=456) and the other half to the validation sample (n=455);

there are no significant differences in gender, education, age, race and health literacy as assessed by the REALM-R, NVS, BHLS or SILS between the estimation and validation samples based on two-sample test for proportions (gender, education, race, REALM-R, NVS, SILS) and two-sample t-test (BHLS, age); see Table 1.

[Insert Table 1]

REALM-R Estimation

Table 2 presents the model results and goodness of fit statistics for five REALM-R estimation models. All demographic predictors, with the exception of age, were statistically significant in the base model that contained demographic predictors only (age, education, gender, and race); the goodness of fit statistics suggested a model with fair estimation ability (R^2=0.34, AIC=505, AUROC=0.79). Addition of the "difficulty with written information" SILS (Model 2A) created a model that identified limited health literacy (R^2=0.38, AIC=491, AUROC=0.81) better than the base model. Models 3A and 4A containing the two other SILS items and Model 5A containing the BHLS did not identify patients with limited health literacy as well as Model 2A.

[Insert Table 2]

NVS Estimation

All demographic predictors, except gender, were statistically significant in the base model that contained demographic predictors only; the goodness of fit statistics suggested a model with fair estimation ability (R^2=0.20, AIC=535, AUROC=0.73). Addition of the "difficulty with written information" SILS (Model 2B) with demographics identified patients with limited health literacy (R^2=0.23, AIC=525, AUROC=0.75) better than the demographics only model. Models 3B and 4B containing the two other SILS items did not identify patients with limited health literacy as well

as Model 2B. The full BHLS (Model 5B) had slightly better estimation (R^2=0.24, AIC=524, AUROC=0.75) than the one SILS item (Model 2B).

Validation

Using model coefficients and lowest misclassification cut-offs the validation sample was used to compare estimation of limited health literacy for the models with the "difficulty with written information" SILS (Model 2) and the BHLS (Model 5) to both objective health literacy assessments (REALM-R, NVS).

Difficulty Understanding Written Information SILS

The addition of the "difficulty with written information" SILS to demographic information (age, gender, race, education) has the ability to identify limited health literacy on the REALM-R with a sensitivity of 62%, specificity of 81%, 28% misclassification rate, and a moderate kappa statistic of 0.43 (95%CI: 0.35, 0.51)[38]. The likelihood ratio of a positive test result (LR^+) is 3.26, the likelihood ratio of a negative test (LR^-) is 0.47; this model slightly underestimates (39%) limited health literacy in the sample (Table 3). This model showed greater sensitivity (82%) and lower specificity (68%) in estimating the NVS attenuating the positive likelihood ratio (2.56) and improving the negative likelihood ratio (0.26). The NVS estimation model also had a lower misclassification rate (24%) and slight increase in kappa statistic of 0.49 (95%CI: 0.41, 0.57); this model estimates limited health literacy among 63% of the sample.

[Insert Table 3]

Brief Health Literacy Screen

The addition of the BHLS to demographic information has the ability to estimate limited health literacy on the REALM-R with a sensitivity of 80%, specificity of 62%, $LR^+ = 2.11$, $LR^- = 0.32$, 30% misclassification rate, and a moderate kappa statistic of 0.42 (95%CI: 0.34, 0.50)[38]. This model estimates 58% limited health literacy in the sample; overestimating limited health literacy (Table 3). The BHLS estimation model had slightly lower sensitivity (77%) and higher specificity (72%) for estimating the NVS; improving the LR^+ (2.75) and preserving LR^- (0.32). The NVS estimation model also had a lower misclassification rate (25%) and slight increase in kappa statistic of 0.48 (95%CI: 0.40, 0.56); this model estimates limited health literacy among 59% of the sample underestimating limited health literacy (Table 3).

Discussion

The utility of SILS items and the BHLS in clinical practice have been demonstrated[18,39,40]; we extend this work to examine predictive ability compared to and combined with demographic characteristics that can be easily collected in clinical settings. Age, gender, race, education, and one SILS item (difficulty understanding written information) were found to be predictors of limited health literacy and combined yielded the best estimation model for limited health literacy measured by the REALM-R and NVS; this model identified patients with limited health literacy better than demographic factors alone. We posit that differences between the results of our analyses and previous studies could be attributed to sample demographics and analysis techniques. Our sample included only English speakers and was predominately non-white (69% black); we used regression analytic approaches, assessed two objective measures of health

literacy (REALM-R and NVS), as well as multiple predictors of limited health literacy in both ED and primary care settings. Most previous studies have examined only one objective measure of health literacy, among patients in only one clinical setting (primary care), and do not report likelihood ratios to facilitate clinical interpretation of these health literacy screening test results[19,39,41]. The extension of this work to the ED has important implications as the majority of rural EDs are staffed by family medicine physicians[42–44].

BHLS estimation models have slightly higher misclassification rates than the "difficulty understanding written information" SILS estimation models for both REALM-R and NVS suggesting that the use of one SILS item in addition to demographic information can improve the ability to identify limited health literacy in fast paced clinical settings serving medically underserved populations. However, despite being easier to administer in clinical settings, SILS subjective measures of health literacy have misclassification rates over 20% when used in addition to known demographic predictors and do not replace objective measures.

Our study had several limitations that should be considered when interpreting findings. This is a convenience sample of English-speaking ED and primary care patients at a single urban academic medical center; analysis is limited to black and white respondents due to the small number of patients from other racial/ ethnic groups limiting generalizability of findings to other populations. As with most health literacy measures, SILS items do not assess oral communication, listening, writing[45], visual literacy[46], and do not consider aging, gender, language, culture, education, health condition, and health care settings[47]. While we did see

variability in health literacy, most of the sample had at least a high school education and we excluded those with visual impairments from our study as the health literacy measures are not validated for this population.

While the NVS can be performed in less than three minutes[11,41] this still requires staff to administer the test and so is not feasible in many clinical settings; there has been some work to examine feasibility of a self-administered NVS but the instrument has yet to be validated[48]. In the present study we validate our limited health literacy estimation model against two validated objective health literacy measures (REALM-R and NVS).

Conclusions

Our findings endorse the utility of one SILS question combined with demographics in order to identify patients with limited health literacy in fast-paced clinical settings rather than objective assessments that may not be feasible. Future research is needed to refine these models and predictors that decrease misclassification rates and examine the validity of this approach in other populations. It is important to note that given the high misclassification rates universal precautions should be considered for use in all patients [49,50].

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Table 1: Demographic Characteristics of Participants in the Overall, Estimation, and Validation Samples

Variables	Overall (N=911)		Estimation (n=456)		Validation (n=455)		p-value*
Gender	**n**	**%**	**n**	**%**	**n**	**%**	
Male	353	38.7	174	38.2	179	39.3	0.83
Female	558	62.3	282	61.8	276	60.7	0.79
Education							
< High School	156	17.1	78	17.1	78	17.1	1.00
High School	395	43.4	201	44.0	194	42.6	0.78
> High School	360	39.5	177	38.8	183	40.2	0.79
Race							
White	308	33.8	151	33.1	157	34.5	0.80
Black	603	66.2	305	66.9	298	65.5	0.72
Difficulty with written information							
Always/Often/Sometimes	251	27.6	151	20.4	100	22.0	0.79
Rarely/Never	660	72.4	305	79.6	355	78.0	0.60
Confidence in filling out medical forms							
Not at all/A little bit/Somewhat	348	38.2	179	39.3	169	37.1	0.67
Quite a bit/Extremely confident	563	61.8	277	60.8	286	62.9	0.61
Help reading hospital material							
Always/Often/Sometimes	233	25.6	123	27.0	110	24.2	0.63
Rarely/Never	678	74.4	333	73.0	345	75.8	0.40
Rapid Estimation of Adult Literacy in Medicine-Revised							
Limited health literacy	418	45.9	205	45.0	213	46.8	0.71
Adequate health literacy	493	54.1	251	55.0	242	53.2	0.69
Newest Vital Sign							
Limited health literacy	578	63.4	292	64.0	286	62.9	0.79
Adequate health literacy	333	36.6	164	36.0	169	37.1	0.83
	Mean	**St. dev†**	**Mean**	**St. dev**	**Mean**	**St. dev**	**p-value‡**
Brief Health Literacy Screen	12.1	2.8	12.1	2.7	12.1	2.8	0.78
Age	48.5	14	48.5	14.0	48.4	14.1	0.88

*two-sample test for proportions

†St. dev= Standard deviation

‡two-sample t-test

Table 2A: Logistic Regression Models Estimating Limited Health Literacy against the Rapid Estimate of Adult Literacy in Medicine-Revised

Model	Demographics Only				Difficulty with written information SILS*				Confidence filling out medical forms SILS				Help reading hospital materials SILS				BHLS†			
Predictors	**OR**	**95%CI**		**p**	**OR**	**95%CI**		**p**	**OR**	**95%CI**		**p**	**OR**	**95%CI**		**p**	**OR**	**95%CI**		**p**
Age	0.99	0.98	1.01	0.34	0.99	0.97	1.01	0.21	0.99	0.98	1.01	0.21	0.99	0.98	1.01	0.32	0.99	0.97	1.01	0.19
Gender																				
(reference= Male)																				
Female	0.45	0.29	0.71	<0.01	0.45	0.28	0.72	<0.01	0.45	0.28	0.70	<0.01	0.47	0.30	0.74	<0.01	0.45	0.28	0.71	<0.01
Race (reference=White)																				
Black	8.25	4.89	13.90	<0.01	8.76	5.10	15.06	<0.01	8.10	4.80	13.67	<0.01	8.25	4.87	14.00	<0.01	8.21	4.83	13.96	<0.01
Education (reference=High School)																				
<High School	2.57	1.36	4.84	<0.01	1.97	1.02	3.79	<0.01	2.51	1.33	4.74	<0.01	2.22	1.17	4.24	0.02	2.18	1.14	4.15	0.02
> High School	0.35	0.22	0.56	<0.01	0.37	0.23	0.61	<0.01	0.37	0.23	0.59	<0.01	0.35	0.21	0.56	<0.01	0.37	0.23	0.60	<0.01
Difficulty with written information SILS (reference=Rarely/Never)																				
Always/often/Sometimes					3.14	1.75	5.65	<0.01												
Confidence filling out medical forms SILS (reference=Quite a bit/Extremely confident)																				
Not at all/A little bit/ Somewhat									1.35	0.87	2.12	0.19								
Help reading hospital materials SILS (reference=Rarely/Never)																				
Always/often/Sometimes													1.94	1.18	3.18	0.01				
Brief Health Literacy Screen																	0.88	0.81	0.96	<0.01
Goodness of Fit Statistics																				
R^2	0.342				0.375				0.346				0.357				0.361			
AIC	505.02				491.46				505.27				500.08				498.07			
AUROC	0.794				0.812				0.800				0.803				0.809			

*SILS are Single Item Literacy Screeners

†BHLS is the Brief Health Literacy Screen

Table 2B: Logistic Regression Models Estimating Limited Health Literacy against the Newest Vital Sign

Model	Demographics Only				Difficulty with written information SILS*				Confidence filling out medical forms SILS				Help reading hospital materials SILS				BHLS†			
Predictors	**OR**	**95%CI**		**p**	**OR**	**95%CI**		**p**	**OR**	**95%CI**		**p**	**OR**	**95%CI**		**p**	**OR**	**95%CI**		**p**
Age	1.02	1.01	1.04	<0.01	1.02	1.01	1.04	0.01	1.02	1.01	1.04	<0.01	1.02	1.01	1.04	<0.01	1.02	1.01	1.04	0.01
Gender																				
(reference=Male)																				
Female	0.93	0.60	1.44	0.75	0.95	0.61	1.48	0.83	0.92	0.60	1.43	0.72	0.96	0.62	1.49	0.85	0.94	0.06	1.46	0.79
Race (reference=White)																				
Black	3.51	2.27	5.43	<0.01	3.50	2.25	5.45	<0.01	3.41	2.20	5.28	<0.01	3.41	2.20	5.29	<0.01	3.33	2.14	5.18	<0.01
Education (reference=High School)																				
<High School	2.06	1.03	4.13	0.04	1.68	0.82	3.44	0.15	1.97	0.98	3.97	0.06	1.84	0.97	3.73	0.06	1.75	0.86	3.57	0.12
> High School	0.40	0.25	0.62	<0.01	0.43	0.27	0.67	<0.01	0.42	0.27	0.67	<0.01	0.41	0.26	0.64	<0.01	0.44	0.28	0.67	<0.01
Difficulty with written information SILS (reference=Rarely/Never)																				
Always/often/Sometimes					2.86	1.50	5.46	<0.01												
Confidence filling out medical forms SILS (reference=Quite a bit/Extremely confident)																				
Not at all/A little bit/ Somewhat									1.61	1.03	2.52	0.04								
Help reading hospital materials SILS (reference=Rarely/Never)																				
Always/often/Sometimes													1.80	1.08	3.00	0.02				
Brief Health Literacy Screen																	0.85	0.78	0.94	
Goodness of Fit Statistics																				
R^2	0.203				0.232				0.214				0.216				0.235			
AIC	534.75				525.27				532.29				531.46				524.15			
AUROC	0.734				0.749				0.738				0.741				0.749			

*SILS are Single Item Literacy Screeners

†BHLS is the Brief Health Literacy Screen

Table 3: Comparison of SILS/BHLS Model Identification of Limited Health Literacy With Objective Health Literacy Measures (REALM-R and NVS*)

	Limited Health Literacy		Adequate Health Literacy							Likelihood Ratio†	
	n	%	n	%	Kappa	95% CI		% misclassified	Sensitivity	Specificity	LR^+	LR^-
Difficulty with Written Information SILS and Demographics Model												
REALM-R Limited Health Literacy	132	62.0	81	38.0	0.43	0.35	0.51	28.1	0.62	0.81	3.26	0.47
REALM-R Adequate Health Literacy	47	19.4	195	80.6								
NVS Limited Health Literacy	233	81.5	53	18.5	0.49	0.41	0.57	23.7	0.82	0.68	2.56	0.26
NVS Adequate Health Literacy	55	32.5	114	67.5								
Brief Health Literacy Screen and Demographics Model												
REALM-R Limited Health Literacy	171	80.3	42	19.7	0.42	0.34	0.50	29.5	0.80	0.62	2.11	0.32
REALM-R Adequate Health Literacy	92	38.0	150	62.0								
NVS Limited Health Literacy	221	77.3	65	22.7	0.48	0.40	0.56	24.8	0.77	0.72	2.75	0.32
NVS Adequate Health Literacy	48	28.4	121	71.6								

*REALM-R is the Rapid Estimate of Health Literacy in Medicine-Revised; NVS is the Newest Vital Sign

†LR^+ is the likelihood ratio of a positive test result; LR^- is the likelihood ratio of a negative test result

‡Models control for age, gender, race, and education