

Health Literacy and Outcomes Among Patients With Heart Failure

Pamela N. Peterson, MD, MSPH

Susan M. Shetterly, MS

Christina L. Clarke, BS

David B. Bekelman, MD, MPH

Paul S. Chan, MD, MSc

Larry A. Allen, MD, MHS

Daniel D. Matlock, MD, MSPH

David J. Magid, MD, MPH

Frederick A. Masoudi, MD, MSPH

AS DEFINED BY THE INSTITUTE of Medicine, health literacy is “the degree to which individuals can obtain, process and understand basic health information and services needed to make appropriate health decisions.”¹ Because health literacy encompasses more than simply the ability to read, patients may have adequate general literacy but low health literacy. Many US citizens and as many as 1 in 3 Medicare enrollees have low health literacy.² The economic implications of low health literacy are substantial, in some estimates accounting for up to 5% of health care costs annually.³

Heart failure is a common and complex chronic disease with high morbidity and mortality and thus has the attention of policy makers as a high-priority condition. Although patients with heart failure are frequently hospitalized, much care for heart failure is performed on a daily basis by individual patients outside of the hospital. This self-care requires integration and application of knowledge and skills.⁴ Therefore, an adequate level of health

Context Little is known about the effects of low health literacy among patients with heart failure, a condition that requires self-management and frequent interactions with the health care system.

Objective To evaluate the association between low health literacy and all-cause mortality and hospitalization among outpatients with heart failure.

Design, Setting, and Patients Retrospective cohort study conducted at Kaiser Permanente Colorado, an integrated managed care organization. Outpatients with heart failure were identified between January 2001 and May 2008, were surveyed by mail, and underwent follow-up for a median of 1.2 years. Health literacy was assessed using 3 established screening questions and categorized as adequate or low. Responders were excluded if they did not complete at least 1 health literacy question or if they did not have at least 1 year of enrollment prior to the survey date.

Main Outcome Measures All-cause mortality and all-cause hospitalization.

Results Of the 2156 patients surveyed, 1547 responded (72% response rate). Of 1494 included responders, 262 (17.5%) had low health literacy. Patients with low health literacy were older, of lower socioeconomic status, less likely to have at least a high school education, and had higher rates of coexisting illnesses. In multivariable Cox regression, low health literacy was independently associated with higher mortality (unadjusted rate, 17.6% vs 6.3%; adjusted hazard ratio, 1.97 [95% confidence interval, 1.3-2.97]; $P=.001$) but not hospitalization (unadjusted rate, 30.5% vs 23.2%; adjusted hazard ratio, 1.05 [95% confidence interval, 0.8-1.37]; $P=.73$).

Conclusion Among patients with heart failure in an integrated managed care organization, low health literacy was significantly associated with higher all-cause mortality.

JAMA. 2011;305(16):1695-1701

www.jama.com

literacy is likely critical in ensuring patient compliance and proficiency in self-management.

Little is known about the association between health literacy and outcomes among patients with heart failure.⁵ While some studies suggest an association between health literacy and outcomes in relatively healthy general populations, these studies evaluated health literacy with complex time-consuming measures that are not conducive to routine use in clinical practice.⁶⁻⁹ Furthermore, prior studies were not able to adjust adequately for coexisting illnesses, which are important fac-

tors related to hospitalization and mortality. Therefore, the objective of this study was to evaluate the association be-

Author Affiliations: Denver Health Medical Center, Denver, Colorado (Drs Peterson and Masoudi); Kaiser Permanente Colorado Institute for Health Research, Denver (Drs Peterson, Magid, and Masoudi and Mss Shetterly and Clarke); University of Colorado Denver, Aurora, Colorado (Drs Peterson, Bekelman, Allen, Matlock, Magid, and Masoudi); Colorado Cardiovascular Outcomes Research Consortium (Drs Peterson, Bekelman, Allen, Matlock, Magid, and Masoudi and Mss Shetterly and Clarke); Denver VA Medical Center, Denver (Dr Bekelman); and Saint Luke's Mid America Heart Institute and University of Missouri, Kansas City (Dr Chan).

Corresponding Author: Pamela N. Peterson, MD, MSPH, Division of Cardiology, Denver Health Medical Center, Mail Code 0960, 777 Bannock St, Denver, CO 80204 (pamela.peterson@ucdenver.edu).

tween low health literacy and all-cause mortality and hospitalization among a population of outpatients with heart failure using 3 brief screening questions that can be easily incorporated into clinical practice.

METHODS

Study Population

All patients were enrolled in Kaiser Permanente of Colorado (KPCO), a nonprofit managed care organization that provides medical services (inpatient, outpatient, pharmacy) to more than 480 000 persons. The study cohort included patients with a primary hospital discharge diagnosis of heart failure (*International Classification of Diseases, Ninth Revision [ICD-9] codes 428.xx, 398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, or 404.93 or a diagnosis related group of 127*) and patients who had at least 2 secondary hospital discharge diagnoses of heart failure in which the primary discharge diagnosis was related to cardiovascular disease (*ICD-9 codes 410, 412, 413, or 414*) or 3 or more emergency department visits with a diagnosis of heart failure between January 1, 2001, and May 31, 2008. Prior literature suggests that these administrative coding algorithms have a high positive predictive value for a diagnosis of heart failure when validated with chart review.¹⁰⁻¹² Patients underwent follow-up through March 31, 2009, for subsequent events.

Survey

All patients identified as having heart failure who were still alive between 2007 and 2008 were surveyed. The survey was mailed, with a second mailing sent to nonresponders. Those not responding to the second mailing were called. Up to 10 attempts were made to contact nonresponders. If participants were reached, they were given the option of completing the survey by telephone interview.

The study was approved by the KPCO institutional review board. Informed consent was waived for the survey, which was conducted under Kai-

ser Permanente operations to evaluate patient satisfaction. However, the survey was explained in the mailed material with notification that it was voluntary and would not influence care, and each survey was accompanied by a postage-paid opt-out postcard, allowing patients to easily indicate if they did not want to participate.

Health Literacy

Health literacy was assessed using 3 brief screening questions with established validity for identifying patients with limited and marginal health literacy skills¹³⁻¹⁶: (1) How often do you have someone help you read hospital materials? (2) How often do you have problems learning about your medical condition because of difficulty reading hospital materials? and (3) How confident are you filling out forms by yourself? Each question was scored by patients on a 5-point scale in which higher scores indicated lower literacy. The performance characteristics of each of these questions has been previously evaluated and compared against the Short Test of Functional Health Literacy in Adults or the Rapid Estimate of Adult Literacy in Medicine as the reference standard.¹³⁻¹⁷

Health literacy was evaluated as a continuous, ordinal, and dichotomous variable. The different specifications were found to explain similar amounts of variance, so the simplest specification (adequate vs low) was used in the statistical models. Based on prior literature,^{13,17} scores were summed and dichotomized a priori such that a total score greater than 10 was categorized as low health literacy and a score of 10 or lower as adequate health literacy.

Outcomes

The primary outcomes of interest were all-cause mortality and all-cause hospitalization. These outcomes were chosen because they are patient-centered and are quality measures used by the Centers for Medicare & Medicaid Services for hospital heart failure–related quality assessment and

reporting. Therefore, these outcomes are important targets for quality improvement efforts. Vital status was ascertained from KPCO databases and validated by comparison with death certificates registered with the state of Colorado. Hospitalizations were identified using claims data. Hospitalizations outside of the managed care organization are also captured in the administrative claims data.

Other Variables

Covariates collected were age, sex, race/ethnicity, socioeconomic status, self-reported education level, residential status (independent vs nursing facility or hospice care), serum creatinine level, left ventricular ejection fraction, year of cohort entry, receipt of β -blockers and angiotensin-converting enzyme inhibitors or angiotensin receptor blockers, and history of coexisting illnesses (angina, liver disease, chronic obstructive pulmonary disease, dementia, diabetes, history of myocardial infarction, hypertension, major psychiatric disorder, metastatic cancer, peripheral vascular disease, stroke, and valvular heart disease). All covariates were determined at the time of the survey, except for residence in a nursing facility or enrollment in hospice, which was determined at any time in the following year. Race/ethnicity was included as a covariate because evidence suggests a relationship between race/ethnicity and outcomes in patients with cardiovascular disease as well as health literacy; race/ethnicity was determined by self-report through the survey.

Automated KPCO databases were used to determine patient demographics, residence in a nursing facility, enrollment in hospice, and laboratory data and to define comorbid conditions using *ICD-9* codes. Automated KPCO pharmacy databases were used to determine dispensing of medication. Socioeconomic status was determined by matching residential address with census data. Low socioeconomic status was defined as living in an area in which at least 20% of

individuals had household incomes below the poverty level or in which at least 25% had a high school education or less. Left ventricular ejection fraction data were obtained by chart review. Education level was ascertained through the survey.

Statistical Analysis

To determine whether a summed unidimensional health literacy scale could be used, we evaluated whether the 3 questions were measuring a single construct by viewing item-to-total correlations and by calculating Cronbach α , which is a measure of consistency among individual items.

Among those completing the survey, 47 (3.2%) did not answer 1 health literacy question and 3 (0.2%) did not answer 2 questions. For the few individuals answering only 1 or 2 of the 3 questions, the score for those questions was multiplied by 3 and 1.5, respectively.

Baseline characteristics were compared across levels of health literacy using the χ^2 test for categorical variables and *t* tests for continuous variables. The bivariate relationships between health literacy and the outcomes of all-cause mortality and hospitalization were each assessed using Kaplan-Meier survival plots with time of survey completion as time zero and evaluated with the log-rank test. To determine the independent association of health literacy with all-cause mortality and hospitalization, multivariable Cox proportional hazards models were constructed for each outcome. All variables were selected a priori based on prior literature and clinical significance. All covariates were included in the primary models except for medications.

Because a large number of variables were included given the number of deaths, in secondary analyses we limited the number of variables included in the models based on clinical and statistical significance. Medications were not included in the models because we were unable to assess for eligibility for these therapies beyond left ventricu-

lar ejection fraction and because of concerns that medication adherence might to some extent mediate the relationship between health literacy and outcomes.

In the case of missing values for a given variable, a separate "missing" category was created and included in the models. The rate of missing data was less than 3% for race/ethnicity, socioeconomic status, education, and living status and 6% for left ventricular ejection fraction. Deaths were censored in the analyses of hospitalization. The Cox proportional hazards assumption was tested and verified for all proportional hazards models by calculating and graphing Schoenfeld residuals by survival time.¹⁸

In addition, we tested for differences in the relationship between health literacy and outcomes among the prespecified subgroups of those living independently vs those in a nursing facility or receiving hospice care at the time of the survey or at any point in the year following. We hypothesized that hospitalizations among patients either in nursing facilities or receiving hospice care would be independent of health literacy level because many self-care activities would be supported or assumed by others. Furthermore, we hypothesized that for patients in hospice, the goals of care would focus on symptom management rather than disease management and include avoiding hospitalization. Therefore, we examined for an interaction between those living independently and those in a nursing facility or receiving hospice care. We used the same multivariable modeling approach used in the primary model, stratified by living independently vs living in a nursing facility or receiving hospice care. The statistical significance of difference among strata was tested with a 2-way interaction term in the full model.

Lastly, to further evaluate whether the association between health literacy and outcomes is independent of dementia, we restricted the cohort to those without a diagnosis of dementia.

For each analysis, the null hypothesis was evaluated at a 2-sided significance level of .05, with 95% confidence intervals (CIs). All analyses were performed using SAS version 9.1 (SAS Institute Inc, Cary, North Carolina).

RESULTS

Among 2156 patients surveyed, 1547 responded, for a 72% response rate. Survey nonresponders were older (77 years vs 74 years; $P < .001$). No statistically significant differences existed between responders and nonresponders with regard to sex, race/ethnicity, socioeconomic status, or comorbidity burden. Of those completing the survey, patients were excluded if they did not complete at least 1 health literacy question ($n=40$) or if they did not have at least 1 year of enrollment prior to the survey date ($n=13$). A total of 1494 patients were included in the study cohort.

We evaluated a summed health literacy scale using all 3 health literacy questions. The correlations of single items to the total were 0.62, 0.53, and 0.60 for questions 1 through 3, respectively, and all 3 items were positively correlated with each other (Pearson correlation coefficients ranged from 0.46-0.56). The Cronbach α for the summed score was 0.75, indicating high internal consistency. Thus, the summed scale was used for analyses.

Of the 1494 patients in the cohort, 262 (17.5%) had low health literacy. Patients with low health literacy were older, of lower socioeconomic status, and less likely to have at least a high school education (TABLE). They were also more likely to have coexisting illnesses such as diabetes, hypertension, chronic pulmonary disease, and stroke.

The median length of follow-up was 1.2 (interquartile range, 0.25-1.25) years. There were a total of 124 deaths during follow-up, with 46 deaths (17.6%) in the low health literacy group and 78 (6.3%) in the adequate health literacy group. In Kaplan-Meier analysis, the unadjusted rate of mortality was higher among those with low health lit-

eracy (unadjusted hazard ratio [HR], 2.96 [95% CI, 2.05-4.25]; log-rank $P < .001$) (FIGURE). Similarly, there were a total of 366 hospitalizations during follow-up, with 80 hospitalizations (30.5%) in the low health literacy group and 286 (23.2%) in the

adequate health literacy group. The unadjusted rate of hospitalization was higher among those with low health literacy (unadjusted HR, 1.45 [95% CI, 1.13-1.86]; log-rank $P < .001$) (Figure).

After adjusting for demographic variables, socioeconomic status, educa-

tion, comorbid conditions, year of cohort entry, and left ventricular ejection fraction, low health literacy remained independently associated with an increased risk of mortality (17.6% vs 6.3%; HR, 1.97 [95% CI, 1.3-2.97]; $P = .001$). In adjusted models, low health literacy was not significantly associated with all-cause hospitalization (30.5% vs 23.2%; HR, 1.05 [95% CI, 0.8-1.37]; $P = .73$).

In stratified analyses according to living independently vs residence in a nursing facility or receipt of hospice, there was no difference in the association between health literacy and all-cause mortality ($P = .25$ for interaction). However, the association between low health literacy and all-cause hospitalization differed among the 2 strata. Low health literacy was not significantly associated with hospitalization among persons living independently (29.8% vs 19.5%; HR, 1.33 [95% CI, 0.98-1.80]) but was associated with a lower risk of hospitalization among persons in nursing facilities or receiving hospice care (33.3% vs 57.4%; HR, 0.57 [95% CI, 0.34-0.97]; $P = .006$ for interaction). After excluding patients with dementia, results were consistent with the findings in the overall cohort. Lastly, the association between health literacy and outcomes remained stable when the number of covariates included in the models was changed.

COMMENT

In this insured population with heart failure, low health literacy as assessed by 3 brief screening questions was present in more than 1 in 6 patients. After adjustment for a wide range of clinical and sociodemographic factors, low health literacy was associated with a significantly increased risk of all-cause mortality. These findings suggest that these questions can be used to identify patients vulnerable to adverse outcomes. The results also highlight a potential target for interventions to improve the overall quality of care for patients with heart failure.

To our knowledge, no prior study has evaluated the association between

Table. Baseline Characteristics by Level of Health Literacy

Characteristic	Total Cohort (n = 1494)	No. (%)		P Value
		Level of Health Literacy		
		Adequate (n = 1232)	Low (n = 262)	
Demographic				
Age, mean (SD), y	74.9 (10.7)	74.2 (10.6)	78.6 (10.3)	<.001
Men	699 (46.8)	589 (47.8)	110 (42.0)	.09
Race/ethnicity				
White	1201 (82.0)	1001 (83.1)	200 (77.2)	.11
Hispanic	139 (9.5)	107 (8.9)	32 (12.4)	
Black	78 (5.3)	63 (5.2)	15 (5.8)	
Other	46 (3.1)	34 (2.8)	12 (4.6)	
Missing	30 (2.0)	27 (2.2)	3 (1.2)	.27
Socioeconomic status^a				
Low	312 (21.4)	236 (19.7)	76 (29.3)	.001
Missing	34 (2.3)	31 (2.6)	3 (1.2)	.16
Education				
<High school	242 (16.5)	151 (12.5)	91 (35.0)	<.001
Missing	23 (1.5)	21 (1.7)	2 (0.8)	.26
Hospice or nursing facility	176 (11.8)	122 (9.9)	54 (20.6)	<.001
Clinical				
Left ventricular ejection fraction				
Normal	829 (59.1)	684 (58.9)	145 (60.4)	.86
Mild dysfunction	195 (13.9)	164 (14.1)	31 (12.9)	
Moderate dysfunction	192 (13.7)	157 (13.5)	35 (14.6)	
Severe dysfunction	186 (13.3)	157 (13.5)	29 (12.1)	
Missing	92 (6.2)	70 (5.7)	22 (8.4)	.10
Comorbid conditions				
Abnormal creatinine ^b	431 (28.9)	335 (27.2)	96 (36.6)	.002
Hypertension	1398 (93.6)	1145 (92.9)	253 (96.6)	.03
Valvular heart disease	916 (61.3)	750 (60.9)	166 (63.4)	.45
Diabetes	788 (52.7)	626 (50.8)	162 (61.8)	.001
COPD	665 (44.5)	529 (42.9)	136 (51.9)	.008
PVD	574 (38.4)	451 (36.6)	123 (46.9)	.002
Angina	496 (33.2)	401 (32.5)	95 (36.3)	.25
Psychiatric disorder	395 (26.4)	304 (24.7)	91 (34.7)	.001
History of myocardial infarction	302 (20.2)	236 (19.2)	66 (25.2)	.03
Stroke	255 (17.1)	193 (15.7)	62 (23.7)	.002
Dementia	173 (11.6)	106 (8.6)	67 (25.6)	<.001
Cancer	61 (4.1)	45 (3.7)	16 (6.1)	.07
Chronic liver disease	40 (2.7)	29 (2.4)	11 (4.2)	.09
Medications				
β-Blockers	1089 (72.9)	906 (73.5)	183 (69.9)	.22
ACE inhibitors or ARBs	987 (66.1)	837 (67.9)	150 (57.3)	<.001

Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; COPD, chronic obstructive pulmonary disease; PVD, peripheral vascular disease.

^aLow indicates living in a census tract where at least 20% of individuals had household incomes below the poverty level or at least 25% of the people had a high school education or less.

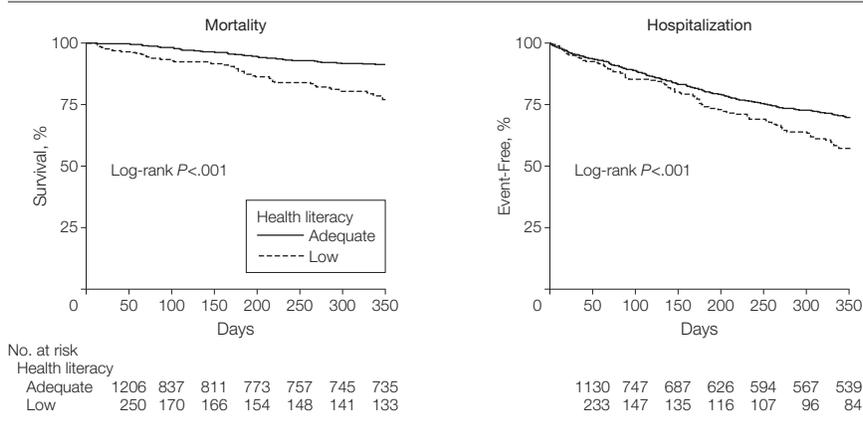
^bCreatinine level greater than or equal to 1.5 mg/dL (132.6 μmol/L).

health literacy and outcomes among patients with heart failure using brief screening questions.^{5,19} Existing studies of health literacy and outcomes have used more complex, interviewer-administered instruments to measure health literacy that are impractical for use in busy clinical settings. Despite differences in the nature of health literacy assessment techniques, our results are consistent with those of prior studies that identified limited health literacy as a risk factor for mortality among healthy, community-dwelling elderly patients.^{8,9}

Our results showing no association between literacy and all-cause hospitalization are in contrast to those from prior studies that found a significant association with hospitalization in a younger, healthier public hospital population and among a Medicare managed care population.^{6,7} However, these studies did not adequately account for comorbid conditions, important factors related to hospitalization. We found that among patients with heart failure, the relationship between health literacy and hospitalization differed among those living independently vs those in a nursing facility or receiving hospice care. It is of interest that those with low health literacy in a nursing facility or hospice were less likely to be hospitalized. This is consistent with the findings of Baker et al⁷ that low health literacy was not a risk factor for hospitalization among individuals with poor physical health. In nursing facility and hospice settings, low health literacy may serve as a marker of patients with even greater limitations who are more completely reliant on caretakers and for whom avoiding hospitalization may be a primary goal of care.

Routine assessment of health literacy may help to identify a greater number of patients at risk for adverse outcomes. Many, including the Heart Failure Society of America, suggest that health literacy levels be documented in the medical record.⁵ However, methods of identifying patients with low health literacy need to be refined.^{5,17}

Figure. Health Literacy and Time to All-Cause Mortality and All-Cause Hospitalization



While patient demographics such as older age, minority race/ethnicity, and low socioeconomic status have been correlated with low health literacy, identification using these factors alone is inadequate.¹⁴ Furthermore, others have demonstrated that use of education level as a surrogate measure of health literacy is also inadequate.⁸ This is consistent with our finding that health literacy was associated with adverse outcomes, independent of education level.

Prior research studies have used more extensive questionnaires such as the Short Test of Functional Health Literacy in Adults or the Rapid Estimate of Adult Literacy in Medicine to identify patients with low health literacy.^{20,21} However, these measures are relatively time-consuming to implement and designed to be administered by an interviewer; therefore, they are not conducive to use in routine clinical settings. Additionally, because these measures are designed to be administered by means of an in-person interview, they may be more likely to invoke feelings of shame, which are common in patients with low health literacy.²² Assessment of health literacy should be performed with care and sensitivity, because the social implications of identifying a patient as being of low health literacy could be counterproductive. Therefore, we assessed health literacy using 3 brief screening questions that could be easily incorpo-

rated into clinical practice. To our knowledge, this is the first study to demonstrate the prognostic value of these screening questions.

Health literacy may affect health and outcomes through a number of mediating processes, including patients' health actions outside of the health system, such as understanding and adhering to disease management and treatment strategies. Prior studies have shown that low health literacy is associated with lower knowledge of one's chronic disease²³ and a greater misunderstanding of medications^{24,25} and therefore with less ability to perform successful self-management of chronic disease. Among patients with heart failure, the ability to read prescription labels—not a measure of health literacy per se—was associated with clinical decompensation and health care utilization.²⁶

Low health literacy also may influence the patient-clinician interaction. For example, patients with low health literacy may be reluctant to ask questions of clinicians and be less likely to participate in making decisions about clinical treatment.²² Furthermore, clinicians may lack competencies to help patients with low health literacy engage in a shared decision-making process. At a minimum, clinicians should be trained to use appropriate teaching methods, reinforce education over time, and check for understanding in all patients with chronic disease. One study

found that when informed of their patient's limited health literacy, physicians were more likely to use recommended communication strategies, underscoring the importance of identifying those with low health literacy.²⁷ More work is needed to incorporate interactive communication and facilitate health education in the patient-clinician interaction, recognizing the responsibility of clinicians in improving these interactions.

Health literacy also may influence one's ability to obtain health care through a lack of insurance or impaired access to care. A strength of this study is that all patients were members of KPCO (ie, all were insured), minimizing differences among patients in the availability of health care and health information. Therefore, lack of insurance and the associated lack of access to care is not a likely explanation for our results. Yet we found that even in this population with health insurance in an integrated delivery system, the prevalence of low health literacy was 1 in 6 and was associated with adverse outcomes. The effect of low health literacy likely differs depending on characteristics of the health care system and patient population. The adverse effect of low health literacy would if anything exert a more pronounced effect for individuals who do not have a regular clinician or who face other significant barriers to obtaining care.

This study identified a strong association between low health literacy and all-cause mortality in outpatients with heart failure. Although this study cannot demonstrate a causal relationship between health literacy and outcomes, it does justify further investigation of health literacy as a potentially modifiable risk factor for adverse outcomes in heart failure. Indeed, we and others believe that an individual's level of health literacy is not a fixed trait but rather a state that, at least in part, reflects the summed context of the demands of one's illness(s), the predominantly paternalistic communication style of the medical community, and the complex structure of the health care

system.^{28,29} Interventions addressing literacy have been shown beneficial in improving quality of life and self-care and suggest possible benefits in reducing hospitalization and mortality among patients with heart failure, further supporting that health literacy may be a modifiable risk factor.^{5,30-32}

The 3 brief screening questions can be used to identify patients with heart failure to whom interventions should be targeted. Ensuring that a patient understands should be a standard part of medical care for all patients. However, limited resources may preclude broad application of activities and structures to address low health literacy, and interventions may need to be targeted to those at highest risk. Potential means of addressing low health literacy for patients with heart failure at the system and clinician level have been proposed and include (1) tailoring of educational materials; (2) use of "teach to goal," an iterative educational process; (3) structured follow-up; and (4) intervisit surveillance and support.^{28,30} An intervention incorporating these elements is currently being evaluated in an ongoing multicenter trial.³⁰

Several factors should be considered in the interpretation of our findings. First, we did not use a more detailed tool to validate low health literacy, and the 3 brief questions may reflect other constructs or be markers of impaired vision, frailty, or cognitive impairment. However, even if these 3 questions measure other constructs, they can easily be incorporated into routine practice and are useful for identifying patients at higher risk. Furthermore, to the extent that the 3-question survey may be more specific than sensitive for literacy compared with more detailed instruments as the criterion standard, we would expect that our results would be biased toward the null.^{13,17} Second, our study population consisted of members of a managed care organization, which may limit the generalizability of our findings. However, as previously discussed, we would expect that the effect of low health lit-

eracy would, if anything, be attenuated in this population and may be even greater in different populations.

Third, this study was performed only among English-speaking patients and may not be generalizable to non-English-speaking persons. Prior studies have found that health literacy is even poorer among non-English speakers.^{7,8} However, the exclusion of those who do not speak English removes language barriers as potential confounders. Fourth, responder bias is a natural limitation of any survey study. However, the survey response rate was high, and responders and nonresponders did not differ with regard to sex, race/ethnicity, socioeconomic status, or comorbidity burden.

In conclusion, this study demonstrates that even among those with health insurance and access to health information, low health literacy as assessed by 3 brief screening questions is associated with higher mortality. This finding supports efforts to determine whether interventions to screen for and address low health literacy can improve important health outcomes in patients with heart failure.

Author Contributions: Dr Peterson had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Peterson, Bekelman, Magid, Masoudi.

Acquisition of data: Shetterly, Clarke, Allen, Masoudi.

Analysis and interpretation of data: Peterson, Shetterly, Bekelman, Chan, Allen, Matlock, Magid, Masoudi.

Drafting of the manuscript: Peterson.

Critical revision of the manuscript for important intellectual content: Shetterly, Clarke, Bekelman, Chan, Allen, Matlock, Magid, Masoudi.

Statistical analysis: Peterson, Shetterly.

Obtained funding: Masoudi.

Administrative, technical, or material support: Clarke, Magid.

Study supervision: Peterson, Bekelman, Allen, Masoudi.

Conflict of Interest Disclosures: All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Chan reported serving as a consultant for Prescription Solutions. Dr Allen reported serving as a consultant for Amgen/Cytokinetics, Otho-McNeil Janssen Scientific Affairs, and for the Robert Wood Johnson Foundation. Dr Masoudi reported having contracts with the Oklahoma Foundation for Medical Quality and the American College of Cardiology Foundation and serving on an advisory board for Amgen. No other authors reported disclosures.

Funding/Support: Dr Peterson is supported by American Heart Association Pharmaceutical Roundtable grant 067001N. Dr Chan is supported by a Career Development Grant Award (K23HL102224) from the Na-

tional Heart, Lung, and Blood Institute. Dr Allen is supported by an American Heart Association Scientist Development Award.

Role of Sponsor: None of the funding organizations had any role in the design and conduct of the study; the collection, management, analysis, and interpretation of the data; or the preparation, review, or approval of the manuscript.

Disclaimer: The views expressed in this article are those of the authors and do not necessarily reflect the views of the Department of Veterans Affairs.

REFERENCES

- Institute of Medicine. *A Prescription to End Confusion*. Washington, DC: National Academies Press; 2004.
- Gazmararian JA, Baker DW, Williams MV, et al. Health literacy among Medicare enrollees in a managed care organization. *JAMA*. 1999;281(6):545-551.
- Eichler K, Wieser S, Brügger U. The costs of limited health literacy: a systematic review. *Int J Public Health*. 2009;54(5):313-324.
- Riegel B, Moser DK, Anker SD, et al; American Heart Association Council on Cardiovascular Nursing; American Heart Association Council on Clinical Cardiology; American Heart Association Council on Nutrition, Physical Activity, and Metabolism; American Heart Association Interdisciplinary Council on Quality of Care and Outcomes Research. State of the science: promoting self-care in persons with heart failure: a scientific statement from the American Heart Association. *Circulation*. 2009;120(12):1141-1163.
- Evangelista LS, Rasmussen KD, Laramie AS, et al. Health literacy and the patient with heart failure—implications for patient care and research: a consensus statement of the Heart Failure Society of America. *J Card Fail*. 2010;16(1):9-16.
- Baker DW, Parker RM, Williams MV, Clark WS. Health literacy and the risk of hospital admission. *J Gen Intern Med*. 1998;13(12):791-798.
- Baker DW, Gazmararian JA, Williams MV, et al. Functional health literacy and the risk of hospital admission among Medicare managed care enrollees. *Am J Public Health*. 2002;92(8):1278-1283.
- Baker DW, Wolf MS, Feinglass J, Thompson JA, Gazmararian JA, Huang J. Health literacy and mortality among elderly persons. *Arch Intern Med*. 2007;167(14):1503-1509.
- Sudore RL, Yaffe K, Satterfield S, et al. Limited literacy and mortality in the elderly: the health, aging, and body composition study. *J Gen Intern Med*. 2006;21(8):806-812.
- Kümler T, Gislason GH, Kirk V, et al. Accuracy of a heart failure diagnosis in administrative registers. *Eur J Heart Fail*. 2008;10(7):658-660.
- Lee DSM, Donovan LM, Austin PCP, et al. Comparison of coding of heart failure and comorbidities in administrative and clinical data for use in outcomes research. *Med Care*. 2005;43(2):182-188.
- Go AS, Yang J, Ackerson LM, et al. Hemoglobin level, chronic kidney disease, and the risks of death and hospitalization in adults with chronic heart failure: the Anemia in Chronic Heart Failure: Outcomes and Resource Utilization (ANCHOR) Study. *Circulation*. 2006;113(23):2713-2723.
- Chew LD, Bradley KA, Boyko EJ. Brief questions to identify patients with inadequate health literacy. *Fam Med*. 2004;36(8):588-594.
- Wallace LS, Rogers ES, Roskos SE, Holiday DB, Weiss BD. Brief report: screening items to identify patients with limited health literacy skills. *J Gen Intern Med*. 2006;21(8):874-877.
- Wallace LS, Cassada DC, Rogers ES, et al. Can screening items identify surgery patients at risk of limited health literacy? *J Surg Res*. 2007;140(2):208-213.
- Chew LD, Griffin JM, Partin MR, et al. Validation of screening questions for limited health literacy in a large VA outpatient population. *J Gen Intern Med*. 2008;23(5):561-566.
- Powers BJ, Trinh JV, Bosworth HB. Can this patient read and understand written health information? *JAMA*. 2010;304(1):76-84.
- Cox D. Regression models and life tables. *J R Stat Soc Series B Stat Methodol*. 1972;34:187-220.
- DeWalt DA, Berkman ND, Sheridan S, Lohr KN, Pignone MP. Literacy and health outcomes: a systematic review of the literature. *J Gen Intern Med*. 2004;19(12):1228-1239.
- Parker RM, Baker DW, Williams MV, Nurss JR. The test of functional health literacy in adults: a new instrument for measuring patients' literacy skills. *J Gen Intern Med*. 1995;10(10):537-541.
- Davis TC, Long SW, Jackson RH, et al. Rapid estimate of adult literacy in medicine: a shortened screening instrument. *Fam Med*. 1993;25(6):391-395.
- von Wagner C, Steptoe A, Wolf MS, Wardle J. Health literacy and health actions: a review and a framework from health psychology. *Health Educ Behav*. 2009;36(5):860-877.
- Williams MV, Baker DW, Parker RM, Nurss JR. Relationship of functional health literacy to patients' knowledge of their chronic disease: a study of patients with hypertension and diabetes. *Arch Intern Med*. 1998;158(2):166-172.
- Davis TC, Wolf MS, Bass PF III, et al. Literacy and misunderstanding prescription drug labels. *Ann Intern Med*. 2006;145(12):887-894.
- Kripalani S, Henderson LE, Chiu EY, Robertson R, Kolm P, Jacobson TA. Predictors of medication self-management skill in a low-literacy population. *J Gen Intern Med*. 2006;21(8):852-856.
- Murray MD, Tu W, Wu J, Morrow D, Smith F, Brater DC. Factors associated with exacerbation of heart failure include treatment adherence and health literacy skills. *Clin Pharmacol Ther*. 2009;85(6):651-658.
- Seligman HK, Wang FF, Palacios JL, et al. Physician notification of their diabetes patients' limited health literacy: a randomized, controlled trial. *J Gen Intern Med*. 2005;20(11):1001-1007.
- Paasche-Orlow MK, Schillinger D, Greene SM, Wagner EH. How health care systems can begin to address the challenge of limited literacy. *J Gen Intern Med*. 2006;21(8):884-887.
- Baker DW. The meaning and the measure of health literacy. *J Gen Intern Med*. 2006;21(8):878-883.
- DeWalt DA, Malone RM, Bryant ME, et al. A heart failure self-management program for patients of all literacy levels: a randomized, controlled trial [ISRCTN11535170]. *BMC Health Serv Res*. 2006;6(30):30.
- Cavanaugh K, Wallston KA, Gebretsadik T, et al. Addressing literacy and numeracy to improve diabetes care: two randomized controlled trials. *Diabetes Care*. 2009;32(12):2149-2155.
- Weiss BD, Francis L, Senf JH, Heist K, Hargraves R. Literacy education as treatment for depression in patients with limited literacy and depression: a randomized controlled trial. *J Gen Intern Med*. 2006;21(8):823-828.