Prognostic implications of a one-item health literacy screen on health status outcomes among heart failure patients with depression

R. Angel Garcia[a,*], **Philip G. Jones**[a], **Kwonho Jeong**[b,d], **Scott D. Rothenberger**[b,d], **Paul S. Chan**[a], **Bea Herbeck Belnap**[b,c], **Amy M. Anderson**[b,c], **Bruce L. Rollman**[b,c], **John A. Spertus**[a]

[a]Saint Luke's Mid America Heart Institute, University of Missouri-Kansas City, United States of America

[b]Division of General Internal Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA, United States of America

[c]Center for Behavioral Health, Media, and Technology, University of Pittsburgh School of Medicine, United States of America

[d]Center for Research on Healthcare Data Center, University of Pittsburgh School of Medicine, United States of America

Abstract

Background: Health literacy (HL) is the degree to which individuals can obtain, process, and understand basic health information and services. Although low HL portends greater risk for clinical events, its association with heart failure (HF)-specific health status– patients' symptoms, function and quality of life– is poorly understood. We thus explored the association of low HL with health status outcomes in depressed patients with HF, for whom treatment regimens can be complex.

Methods: Participants with HF with reduced ejection fraction and depression, from the Hopeful Heart trial, were categorized as having low or adequate HL at baseline using a validated, 1-item HL screen. HF-specific health status was measured at baseline, 3, 6, and 12 months using the

*Corresponding author at: 4401 Wornall Road, Kansas City, MO 64111, United States of America. ragarcia@saintlukeskc.org (R.A. Garcia).

12-item Kansas City Cardiomyopathy Questionnaire (KCCQ-12). Using serial risk-adjusted linear regression models, we assessed the association of HL with baseline, 12-month and 12-month change in the KCCQ Overall Summary (OS) scores (range 0–100; lower scores = worse health status).

Results: Among 629 participants, 35 % had low HL. Those with low HL had lower health status at all time points, including at 12 months after discharge (−9.8 points, 95%CI [−14.3, −5.3], $p < 0.001$), with poorer improvements in KCCQ-OS scores after accounting for baseline health status (−6.4 points, 95%CI [−10.5, −2.3], $p = 0.002$).

Conclusions: In those with HF and depression, low HL was common and associated with worse HF-specific health status and poorer improvement over time. A brief HL screen can identify patients at risk for poorer health status outcomes and for whom additional interventions may be warranted.

Keywords

Depression; Health literacy; Health status; Heart failure; Hopeful heart; Kansas City Cardiomyopathy Questionnaire (KCCQ); Screening

1. Background

As patients navigate through the complexities of their medical conditions and the healthcare system, their personal understanding of health-related matters can be a key determinant of outcomes [1–3]. Health literacy (HL) is the degree to which individuals can obtain, process, and understand basic health information and services, to make appropriate health decisions [4]. Specifically, low HL is widely prevalent, affecting approximately 1 in 3 persons worldwide and an estimated 80 million US adults [5,6]. When compared to those with adequate HL, patients with low HL are more likely to experience negative outcomes, such as lower rates of preventative care and greater use of emergency care services [7]. Despite its prevalence and related impact, screening to identify low HL is uncommon. However, HL measures that are both valid and concise could facilitate the adoption of routine HL screening into clinical care and could help better inform providers of patients who are at greater risk for poor outcomes.

Heart failure (HF) is one of the most common cardiovascular diseases, with an estimated global prevalence of >37 million, affecting over 6 million people in the US [8,9]. It is a complex, chronic medical condition that requires a significant degree of self-management, including adherence to recommended medications and diets, exercise, and self-monitoring of blood pressure, weight, and symptoms. Given the complexity of HF management, it is important to understand how low HL influences the management and outcomes of medical conditions such as HF. A patient's health status – or their symptoms, function and quality of life – is a patient-centered outcome that is of great importance to them [10,11]. However, little is known about the association between low HL and the health status of patients with HF, but it is critical to understand as it could suggest that novel, non-medical interventions may have a significant impact on improving the health status of HF patients.

Depression is also associated with poorer outcomes in those with HF, including poorer health status [12,13]. Given the limited effect of anti-depressant therapy on HF-specific health status outcomes [14], the impact of low HL might be even easier to asses in those with depression, for whom additional interventions or treatment strategies may be required. To address these gaps in knowledge, we analyzed participants with HF and depression, from the National Heart, Lung and Blood Institute-funded Hopeful Heart trial (NCT02044211). We explored the impact of HL screening through a unique, validated measure, and examined the temporal associations between HL and HF-specific health status in those with HF and depression.

2. Methods

The data that support the findings of this study are derived from the Hopeful Heart Trial and are available from the *Hopeful Heart Steering Committee* [15,16]. The Hopeful Heart trial study protocol was approved by the Institutional Review Board at the University of Pittsburgh.

2.1. Data source and study population

Details of the study protocol and main outcomes have been published previously [15,16]. The Hopeful Heart trial was a single-blinded, randomized effectiveness trial conducted at two university-affiliated and six community hospitals in southwestern Pennsylvania between 2014 and 2019 [15]. Among 629 hospitalized recruited participants, all were required to have HF with an ejection fraction of 45 % and symptoms meeting criteria for New York Heart Association (NYHA) functional classes II, III, or IV. All participants underwent cognitive screening using a 6-item instrument [17] where scores range from 0 to 6 and a score of 6 represents normal cognition. Those with severe cognitive impairment or dementia (scores of 3) were excluded. Participants were also required to have depression and were initially screened with the 2-item Patient Health Questionnaire (PHQ-2) prior to discharge. Those with a positive PHQ-2 screen (a response of "yes" to at least 1 PHQ item) were re-assessed 2 weeks after hospital discharge using the 9-item PHQ (PHQ-9) to determine the presence of at least a moderate level of depressive symptoms (PHQ-9 scores of 10) [18,19]. PHQ-9 scores range from 0 to 27 and are separated into categories to correlate clinically with depression severity (scores of 5–9 = mild depressive symptoms, 10–14 = moderate depressive symptoms, 15–19 = moderately-severe depressive symptoms, and 20 = severe depressive symptoms).

All 629 participants, with both HF and depression, were then randomized to one of three treatment groups: usual care, blended care, enhanced usual care. Those within the usual care group received standard care for their HF and depression. Participants in the enhanced usual care group were provided nurse-delivered collaborative care (serial follow-up phone calls and recommendations) for their HF and standard care for their depression, while those randomized to blended care group received collaborative care for both their HF and depression.

Blinded research assessors administered a battery of assessments at baseline (2 weeks after hospital discharge), which included a HL assessment (baseline only), and the HF-specific,

12-item Kansas City Cardiomyopathy Questionnaire (KCCQ-12) at baseline. The KCCQ was also collected at 3, 6, and 12 months.

2.2. Health literacy

To determine literacy through an effective yet practical approach, we defined HL using one highly-predictive question from the 3-item questionnaire on HL [20–24] that was previously validated in patients without severe cognitive impairment or dementia, and assessed in those with HF with reduced ejection fraction [25]. A single question – "How confident are you filling out forms by yourself?" – was found to outperform the full 3-item measure at identifying low HL, and was as good as, or better than, other standard HL measures [23,26]. Thus, given its validity, feasibility, and ease of use, we dichotomized study participants' HL into "low" and "adequate" levels according to their responses to this item (Supplementary appendix, Table S1).

2.3. Study outcomes

Our primary outcome was HF-specific health status at 12 months, as measured by the KCCQ Overall Summary (OS) score. The psychometric properties of the KCCQ are sufficiently well-established that the US Food and Drug Administration has qualified the KCCQ as a clinical outcome assessment [27,28]. The KCCQ-12 is a 12-item, disease-specific measure of how patients perceive HF to cause symptoms (KCCQ-Total Symptoms [TS] domain), limit their physical (KCCQ-Physical Limitation [PL] domain) and social (KCCQ-Social Limitation [SL] domain) function, and impair their quality of life (KCCQ-Quality of Life [QoL] domain) over the past 2 weeks [29,30]. The KCCQ-OS score combines the KCCQ-TS, KCCQ-PL, KCCQ-SL and KCCQ-QoL domains to provide a more holistic summary of patients' health status. Scores for each domain range from 0 to 100, for which 0 represents the worst symptoms, function, and quality of life and 100 represents the best. The KCCQ-OS can be categorized as very poor-to-poor (scores 0–24), poor-to-fair (scores 25–49), fair-to-good (scores 50–74), and good-to-excellent (scores 75–100) health status. Changes in KCCQ scores of 5–9 points, 10–19 points, and 20 points are associated with small-to-moderate, moderate-to-large, and large-to-very large clinically important changes, from both patients' and providers' perspectives [21–23]. These changes are also significantly and independently associated with mortality, hospitalization rates and costs in patients with HF due to reduced and preserved EF, regardless of etiology [31–34].

2.4. Statistical analysis

For our primary analyses, we evaluated the cross-sectional and prognostic associations of HL on KCCQ-OS scores in all participants. Summary statistics (mean, standard deviation, frequency) were stratified by HL at each time point (baseline, 3, 6 and 12 months) overall and by Hopeful Heart treatment groups. Linear regression was then used to estimate the independent association between HL and HF-specific health status through sequential modeling. First, we first adjusted for patient-level variables (age, sex, left ventricular ejection fraction [LVEF], and area of deprivation index [ADI]), and then additionally adjusted for the randomized Hopeful Heart treatment groups and baseline KCCQ-OS scores in our estimates of 12-month scores. This latter model, adjusting for baseline KCCQ-OS,

examined whether the change in HF-specific health status, from baseline to 12-months, was worse in those low HL.

Secondary analyses to model each of the other KCCQ domain (Physical Limitation, Social Limitation, Symptom Frequency and Quality of Life) scores at 12 months, and the change in each KCCQ domain score at 12 months, were conducted while adjusting for the same variables in our primary model. Sensitivity analyses were conducted to determine the association between HL and cardiovascular clinical outcomes through modeling the outcome of HF readmission rates at 12 months using cox regression, adjusting for the same variables in our primary model and while also accounting for the heterogeneity of treatment effect across the Hopeful Heart groups. Mortality was not assessed given its low incidence across these treatment groups (Supplementary Appendix, Table S2).

To further account for the potential impact of cognitive impairment on the 12-month KCCQ-OS scores and change in KCCQ-OS scores at 12 months, we repeated our primary analysis, but only in those with normal cognition (scores of 6 on the 6-item cognitive impairment screen). Moreover, as previous studies have reported differing outcomes [35,36], to examine the effect of education on the differences in KCCQ-OS scores between HL groups, we repeated our primary analysis, including the level of education as an additional covariate. Models did not adjust for employment status as education is a known predictor of employment [37]. Models also did not adjust for baseline PHQ-9 scores to avoid over-adjusting given the strong association between depression and health status [13]. However, in a sensitivity analysis, we repeated our primary analysis with further adjustment for the Patient-Reported Outcomes Measurement Information System (PROMIS) Depression scores, and an interaction between HL and PROMIS Depression scores, to further evaluate the potential effects of depression severity on the association of low HL and health status. The PROMIS Depression scale is a validated patient-reported outcomes measure that serially captures both the affective and cognitive manifestations and changes in depression severity, and it is frequently used in clinical trials as it also has been validated across several clinical disorders with strong responsiveness [38,39].

The rate of missing data for all covariates at baseline was low (0.03 %). The missingness regarding the primary outcome of 12-month KCCQ-OS scores was similar in low vs. adequate HL groups (25 % vs. 27 %, $p = 0.413$). Under the assumption that this data was missing at random, given the balance of missingness among the primary comparative groups and the low rate of missing data for all other covariates, we only included patients with available KCCQ data at 12 months in the longitudinal analyses. All analyses were evaluated at a 2-sided significance level of 0.05 with no adjustments for multiplicity and were performed with Stata/SE 17.0 (StataCorp LLC, College Station, TX).

3. Results

Among 629 participants with HF and depression, 223 (35 %) had low HL (Table 1). Participants with low HL were slightly older (64.7 ± 13.5 vs. 63.0 ± 12.6 years) but were similar in sex and race. Mean LVEF was higher in the low HL group, but was not clinically different, when compared with those having adequate HL (29.7 ± 8.9 % vs. 27.4 ± 9.4 %; p

= 0.003). Mean baseline PHQ-9 scores were also higher in the low HL group (14.7 ± 3.7 vs. 13.7 ± 3.5; $p < 0.001$). Those with low HL had lower levels of education, lower employment rates, and worse clinician-assessed, NYHA functional classes.

Participants with low HL had lower unadjusted baseline KCCQ scores in all domains (Supplementary appendix, Table S3), with KCCQ-OS scores of 37.3 ± 18.8 vs. 42.3 ± 20.4 when compared to those with adequate HL ($p = 0.002$). KCCQ-OS scores improved serially over time for both HL groups (Fig. 1), but those with low HL had persistently lower scores overall, and lower mean unadjusted KCCQ-OS scores at 3 (48.3 ± 23.4 vs. 54.1 ± 22.6, $p = 0.004$), 6 (48.2 ± 23.4 vs. 55.7 ± 24.6, $p = 0.001$), and 12 months (51.4 ± 21.9 vs. 60.6 ± 23.8, $p < 0.001$).

After adjusting for patient factors and randomized treatment group, low HL was strongly and independently associated with lower 12-month KCCQ-OS scores (–9.8 points, 95 % CI [–14.3, –5.3]) (Table 2).

In modeling the change in health status, after further adjustment for baseline KCCQ scores, low HL was associated with less improvement in KCCQ-OS (–6.4 points, 95 % CI [–10.5, –2.3]) at 12 months (Table 3). Accounting for the level of education, cognitive impairment or depression severity did not significantly alter these results (Supplementary Appendix, Tables S4–S7).

Secondary analyses on the association of HL with each of the other KCCQ domains (Supplementary Appendix, Tables S8–9) demonstrated that those with low HL had worse health status at 12 months (Physical Limitation score: –8.43 [–13.97, –2.90] $p = 0.0003$, Social Limitation score: –11.01 [–16.97, –5.04] $p < 0.001$, Symptom Frequency score: –8.97 [–13.58, –4.36] p < 0.001, and Quality of Life score: –9.63 [–14.99, –4.27] p < 0.001), similar to what was found for 12-month KCCQ-OS scores. In those with low HL, the change in 12-month scores for each of the other KCCQ domains was also comparable to the change of 12-month KCCQ-OS scores, and with similar poorer improvements in HF-specific health status at 12 months. After cox regression analysis, heart failure readmission rates at 12 months were no different between those with low and adequate HL (hazard ratio 1.22 [0.87, 1.70] $p = 0.253$).

4. Discussion

HF is a complex, chronic medical condition, and understanding the effect of HL on patients' health status is critical, given that it may mandate different interventions or treatment strategies, rather than merely prescribing additional therapies. Using data from a trial of patients with HF and depression, we found that a 1-item HL measure identified over a third of patients as having low HL, which was associated with worse health status throughout a patients' clinical trajectory and worse improvements over a year after hospitalization. These differences in KCCQ scores were clinically significant, exceeding a well-established 5-point difference between those with low and adequate HL. Collectively, these data suggest that screening for and addressing HL may be an important opportunity to identify patients who are at risk for poorer health status outcomes and recovery after HF hospitalization.

It has been reported that over one-third of HF patients have low HL in several studies, with one systematic review suggesting that low HL is present in 2 out of 5 patients (39 %) with HF [40–43]. Prior studies found an association between low HL and health status, however, this was primarily reflected in the elderly and focused on general, rather than disease-specific, health status [44–47]. For patients with HF, some studies have reported an association with low HL and higher hospitalization rates [48] and mortality [25], which were not confirmed in our analyses and may potentially reflect the effect of other factors such as the Hopeful Heart trial interventions. However, the association between HL and HF-specific health status has not been previously reported and extends the literature by demonstrating that in those with depression and HF, low HL is not only associated with worse HF-specific health status, but it is also associated with poorer improvements in health status over time.

Low HL is a key social determinant of health (SDOH). In the 2020 Scientific Statement from the American Heart Association [49], the effect of HL as a SDOH in HF patients was highlighted as a key predictor of adverse clinical events. Low HL is associated with poor understanding of HF [48,50], poor medication adherence [51,52], poor self-care [53], increased hospitalizations, and increased mortality [48]. For this reason, the National Academy of Medicine proposed several potential solutions to promote a more health-literate society to reduce disparities and support more equitable outcomes [4]. The main intent of this work is to demonstrate how low HL might mediate worse outcomes, through poorer responses to the treatments prescribed by clinicians. Critical to determining such an effect is through screening and identification of those with low HL, in addition to evaluating other potential limiting factors. However, an important feature of our study was that low HL was identified through a single question, which could be potentially feasible for clinicians to integrate into routine clinical care. The feasibility of implementing such a brief, 1-item HL measure into routine care, could be quite impactful given the high prevalence of low HL and its association with adverse outcomes.

As the impact of HL on care and outcomes may be modifiable, strategies to improve HL, or to address it with better educational interventions, are important to develop, test and implement in clinical practice. Potential interventions could include educational forms with easily-readable content and strategies that incorporate images to help foster deeper understanding [54]. In tailoring patient education to each individual patient, potentially including language translation or focused education on identification and prevention of HF decompensation, HL may be improved with the goal of augmenting patients' abilities to self-manage their disease [55,56]. Improved self-managed care is associated with reduced hospitalization and improved survival [57], and efforts designed to address HL and self-care management deserve further study in patients with HF.

Our study should be interpreted in the context of the following limitations. First, given the desire to study a more vulnerable population, our cohort was restricted to those with HF and depression who were enrolled in the Hopeful Heart trial. Moreover, as the Hopeful Heart trial was conducted among several health systems in Pennsylvania, our findings may not be generalizable to HF patients without depression or in different healthcare systems. Second, we were unable to demonstrate whether there was an association between HL and HF-specific health status, independent from depression, and other potential unmeasured

confounders may also limit our study's findings. Third, we defined HL using one question, as opposed to all three questions, from a standardized HL measure. Nonetheless, this question has been previously validated and proven to outperform the full measure in identifying those who low HL, while also being potentially easier to integrate into routine care [23,26]. Finally, the missing data on the primary outcome of 12-month KCCQ-OS scores, due to incompletion/drop-out rates within the Hopeful Heart trial, may have introduced potential biases, but there were few observed differences between those with and without missing data.

In conclusion, among patients with HF with reduced ejection fraction and depression, we found that low HL was common and associated with worse health status at baseline and throughout 12 months, and with poorer improvement in HF-specific health status on follow-up. As the 1-item HL screen is simple and can easily be administered, our findings suggest that HL screening may be more feasible to implement into routine clinical care and may more rapidly identify those at increased risk for poorer health status recovery after discharge. Further research is needed to evaluate interventions for low HL and whether they improve the health status trajectory of HF patients with limited knowledge of their health.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding

References

[1]. Brach CKD, Hernandez LM, Baur C, Parker R, Dreyer B, Ten attributes of health literate health care organizations, NAM Perspect. (2012), 10.31478/201206a .

[2]. Baker DW, The meaning and the measure of health literacy, J. Gen. Intern. Med. 21 (8) (2006) 878–883. [PubMed: 16881951]

[3]. World Health Organization, Health literacy: the solid facts, in: WHO Regional Office of Europe, 2013.

[4]. Institute of Medicine Committee on Health L, in: Nielsen-Bohlman L, Panzer AM, Kindig DA (Eds.), Health Literacy: A Prescription to End Confusion, National Academies Press (US) Copyright 2004 by the National Academy of Sciences, Washington (DC), 2004. All rights reserved.

[5]. Prince LY, Schmidtke C, Beck JK, Hadden KB, An assessment of organizational health literacy practices at an academic health center, Qual. Manag. Health Care 27 (2) (2018) 93–97. [PubMed: 29596270]

[6]. Cuthbertson CC, Heiss G, Wright JD, Camplain R, Patel MD, Foraker RE, et al. , Socioeconomic status and access to care and the incidence of a heart failure diagnosis in the inpatient and outpatient settings, Ann. Epidemiol. 28 (6) (2018) 350–355. [PubMed: 29709334]

[7]. McDonald M, Shenkman LJ, Health literacy and health outcomes of adults in the United States: implications for providers, Internet J. Allied Health Sci. Pract. 16 (4) (2018).

[8]. Ziaeian B, Fonarow GC, Epidemiology and aetiology of heart failure, Nat. Rev. Cardiol. 13 (6) (2016) 368–378. [PubMed: 26935038]

[9]. Virani SS, Alonso A, Benjamin EJ, Bittencourt MS, Callaway CW, Carson AP, et al. , Heart disease and stroke Statistics-2020 update: a report from the American Heart Association, Circulation 141 (9) (2020) e139–e596. [PubMed: 31992061]

[10]. Lewis EF, Johnson PA, Johnson W, Collins C, Griffin L, Stevenson LW, Preferences for quality of life or survival expressed by patients with heart failure, J. Heart Lung Transplant. 20 (9) (2001) 1016–1024. [PubMed: 11557198]

[11]. Tsevat J, Dawson NV, Wu AW, Lynn J, Soukup JR, Cook EF, et al. , Health values of hospitalized patients 80 years or older, JAMA 279 (5) (1998) 371–375. [PubMed: 9459470]

[12]. Sullivan M, Levy WC, Russo JE, Spertus JA, Depression and health status in patients with advanced heart failure: a prospective study in tertiary care, J. Card. Fail. 10 (5) (2004) 390–396. [PubMed: 15470649]

[13]. Rumsfeld JS, Havranek E, Masoudi FA, Peterson ED, Jones P, Tooley JF, et al. , Depressive symptoms are the strongest predictors of short-term declines in health status in patients with heart failure, J. Am. Coll. Cardiol. 42 (10) (2003) 1811–1817. [PubMed: 14642693]

[14]. O'Connor CM, Jiang W, Kuchibhatla M, Silva SG, Cuffe MS, Callwood DD, et al. , Safety and efficacy of sertraline for depression in patients with heart failure: results of the SADHART-CHF (Sertraline against depression and heart disease in chronic heart Failure) trial, J. Am. Coll. Cardiol. 56 (9) (2010) 692–699. [PubMed: 20723799]

[15]. Rollman BL, Anderson AM, Rothenberger SD, Abebe KZ, Ramani R, Muldoon MF, et al. , Efficacy of blended collaborative care for patients with heart failure and comorbid depression: a randomized clinical trial, JAMA Intern. Med. 181 (10) (2021) 1369–1380.

[16]. Herbeck Belnap B, Anderson A, Abebe KZ, Ramani R, Muldoon MF, Karp JF, et al. , Blended collaborative care to treat heart failure and comorbid depression: rationale and study design of the hopeful heart trial, Psychosom. Med. 81 (6) (2019) 495–505. [PubMed: 31083056]

[17]. Callahan CM, Unverzagt FW, Hui SL, Perkins AJ, Hendrie HC, Six-item screener to identify cognitive impairment among potential subjects for clinical research, Med. Care 40 (9) (2002) 771–781. [PubMed: 12218768]

[18]. Kroenke K, Spitzer RL, Williams JB, The patient health Questionnaire-2: validity of a two-item depression screener, Med. Care 41 (11) (2003) 1284–1292. [PubMed: 14583691]

[19]. Kroenke K, Spitzer RL, Williams JB, The PHQ-9: validity of a brief depression severity measure, J. Gen. Intern. Med. 16 (9) (2001) 606–613. [PubMed: 11556941]

[20]. Chew LD, Bradley KA, Boyko EJ, Brief questions to identify patients with inadequate health literacy, Fam. Med. 36 (8) (2004) 588–594. [PubMed: 15343421]

[21]. Lee DS, Donovan L, Austin PC, Gong Y, Liu PP, Rouleau JL, et al. , Comparison of coding of heart failure and comorbidities in administrative and clinical data for use in outcomes research, Med. Care 43 (2) (2005) 182–188. [PubMed: 15655432]

[22]. Go AS, Yang J, Ackerson LM, Lepper K, Robbins S, Massie BM, 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 113 (23) (2006) 2713–2723. [PubMed: 16754803]

[23]. 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. 21 (8) (2006) 874–877. [PubMed: 16881950]

[24]. Wallace LS, Cassada DC, Rogers ES, Freeman MB, Grandas OH, Stevens SL, et al. , Can screening items identify surgery patients at risk of limited health literacy? J. Surg. Res. 140 (2) (2007) 208–213. [PubMed: 17509266]

[25]. Peterson PN, Shetterly SM, Clarke CL, Bekelman DB, Chan PS, Allen LA, et al. , Health literacy and outcomes among patients with heart failure, JAMA 305 (16) (2011) 1695–1701. [PubMed: 21521851]

[26]. Chew LD, Griffin JM, Partin MR, Noorbaloochi S, Grill JP, Snyder A, et al. , Validation of screening questions for limited health literacy in a large VA outpatient population, J. Gen. Intern. Med. 23 (5) (2008) 561–566. [PubMed: 18335281]

[27]. Endocrinology Clinical Outcome Assessments (COA) Qualification Submissions Office of Cardiology H and Nephrology (OCEHM) Division of Cardiovascular and Nephrology (DCN), DDT COA #000084: Kansas City Cardiomyopathy Questionnaire (KCCQ), 2020.

[28]. Gottleib S, Federal Drug Administration Medical Device Development Tool (MDDT) Program, Statement from FDA Commsission Scott Gotlieb, MDM, on New Steps to Advance Medical Device Innovation and Help Patients Gain Faster Access to Beneficial Technologies, 2017.

[29]. Spertus JA, Jones PG, Development and validation of a short version of the Kansas City cardiomyopathy questionnaire, Circ. Cardiovasc. Qual. Outcomes 8 (5) (2015) 469–476. [PubMed: 26307129]

[30]. Spertus JA, Jones PG, Sandhu AT, Arnold SV, Interpreting the Kansas City cardiomyopathy questionnaire in clinical trials and clinical care: JACC state-of-the- art review, J. Am. Coll. Cardiol. 76 (20) (2020) 2379–2390. [PubMed: 33183512]

[31]. Soto GE, Jones P, Weintraub WS, Krumholz HM, Spertus JA, Prognostic value of health status in patients with heart failure after acute myocardial infarction, Circulation 110 (5) (2004) 546–551. [PubMed: 15262843]

[32]. Heidenreich PA, Spertus JA, Jones PG, Weintraub WS, Rumsfeld JS, Rathore SS, et al. , Health status identifies heart failure outpatients at risk for hospitalization or death, J. Am. Coll. Cardiol. 47 (4) (2006) 752–756. [PubMed: 16487840]

[33]. Kosiborod M, Soto GE, Jones PG, Krumholz HM, Weintraub WS, Deedwania P, et al. , Identifying heart failure patients at high risk for near-term cardiovascular events with serial health status assessments, Circulation 115 (15) (2007) 1975–1981. [PubMed: 17420346]

[34]. Chan PS, Soto G, Jones PG, Nallamothu BK, Zhang Z, Weintraub WS, et al. , Patient health status and costs in heart failure: insights from the eplerenone post- acute myocardial infarction heart failure efficacy and survival study (EPHESUS), Circulation 119 (3) (2009) 398–407. [PubMed: 19139382]

[35]. Easton P, Entwistle VA, Williams B, Health in the 'hidden population' of people with low literacy. A systematic review of the literature, BMC Public Health 10 (2010) 459. [PubMed: 20687946]

[36]. Sørensen K, Van den Broucke S, Fullam J, Doyle G, Pelikan J, Slonska Z, et al. , Health literacy and public health: a systematic review and integration of definitions and models, BMC Public Health 12 (2012) 80. [PubMed: 22276600]

[37]. Zajacova A, Lawrence EM, The relationship between education and health: reducing disparities through a contextual approach, Annu. Rev. Public Health 39 (2018) 273–289. [PubMed: 29328865]

[38]. Pilkonis PA, Yu L, Dodds NE, Johnston KL, Maihoefer CC, Lawrence SM, Validation of the depression item bank from the patient-reported outcomes measurement information system (PROMIS) in a three-month observational study, J. Psychiatr. Res. 56 (2014) 112–119. [PubMed: 24931848]

[39]. Schalet BD, Pilkonis PA, Yu L, Dodds N, Johnston KL, Yount S, et al. , Clinical validity of PROMIS depression, anxiety, and anger across diverse clinical samples, J. Clin. Epidemiol. 73 (2016) 119–127. [PubMed: 26931289]

[40]. McNaughton CD Cawthon C Kripalani S Liu D Storrow AB Roumie CL. Health literacy and mortality: a cohort study of patients hospitalized for acute heart failure. J. Am. Heart Assoc;4(5):e001799.

[41]. Fabbri M, Murad MH, Wennberg AM, Turcano P, Erwin PJ, Alahdab F, et al. , Health literacy and outcomes among patients with heart failure: a systematic review and meta-analysis, JACC Heart Fail. 8 (6) (2020) 451–460. [PubMed: 32466837]

[42]. Cajita MI, Cajita TR, Han HR, Health literacy and heart failure: a systematic review, J. Cardiovasc. Nurs. 31 (2) (2016) 121–130. [PubMed: 25569150]

[43]. Macabasco-O'Connell A, DeWalt DA, Broucksou KA, Hawk V, Baker DW, Schillinger D, et al. , Relationship between literacy, knowledge, self-care behaviors, and heart failure-related quality of life among patients with heart failure, J. Gen. Intern. Med. 26 (9) (2011) 979–986. [PubMed: 21369770]

[44]. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K, Low health literacy and health outcomes: an updated systematic review, Ann. Intern. Med. 155 (2) (2011) 97–107. [PubMed: 21768583]

[45]. Wolf MS, Gazmararian JA, Baker DW, Health literacy and functional health status among older adults, Arch. Intern. Med. 165 (17) (2005) 1946–1952. [PubMed: 16186463]

[46]. Javadzade SH, Sharifirad G, Radjati F, Mostafavi F, Reisi M, Hasanzade A, Relationship between health literacy, health status, and healthy behaviors among older adults in Isfahan, Iran, J. Educ. Health Promot. 1 (2012), 31–31. [PubMed: 23555134]

[47]. Liu Y-B, Liu L, Li Y-F, Chen Y-L, Relationship between health literacy, health- related behaviors and health status: a survey of elderly chinese, Int. J. Environ. Res. Public Health 12 (8) (2015) 9714–9725. [PubMed: 26295246]

[48]. Wu J-R, Holmes GM, DeWalt DA, Macabasco-O'Connell A, Bibbins- Domingo K, Ruo B, et al. , Low literacy is associated with increased risk of hospitalization and death among individuals with heart failure, J. Gen. Intern. Med. 28 (9) (2013) 1174–1180. [PubMed: 23478997]

[49]. White-Williams C, Rossi LP, Bittner VA, Driscoll A, Durant RW, Granger BB, et al. , Addressing social determinants of health in the Care of Patients with Heart Failure: a scientific statement from the American Heart Association, Circulation 141 (22) (2020) e841–e863. [PubMed: 32349541]

[50]. Chen AM, Yehle KS, Albert NM, Ferraro KF, Mason HL, Murawski MM, et al. , Relationships between health literacy and heart failure knowledge, self- efficacy, and self-care adherence, Res. Soc. Adm. Pharm. 10 (2) (2014) 378–386.

[51]. Noureldin M, Plake KS, Morrow DG, Tu W, Wu J, Murray MD, Effect of health literacy on drug adherence in patients with heart failure, Pharmacotherapy 32 (9) (2012) 819–826. [PubMed: 22744746]

[52]. Persell SD, Osborn CY, Richard R, Skripkauskas S, Wolf MS, Limited health literacy is a barrier to medication reconciliation in ambulatory care, J. Gen. Intern. Med. 22 (11) (2007) 1523–1526. [PubMed: 17786521]

[53]. Macabasco-O'Connell A, DeWalt DA, Broucksou KA, Hawk V, Baker DW, Schillinger D, et al. , Relationship between literacy, knowledge, self-care behaviors, and heart failure-related quality of life among patients with heart failure, J. Gen. Intern. Med. 26 (9) (2011) 979–986. [PubMed: 21369770]

[54]. Taylor-Clarke K, Henry-Okafor Q, Murphy C, Keyes M, Rothman R, Churchwell A, et al. , Assessment of commonly available education materials in heart failure clinics, J. Cardiovasc. Nurs. 27 (6) (2012) 485–494. [PubMed: 21743339]

[55]. Miller TA, Health literacy and adherence to medical treatment in chronic and acute illness: a meta-analysis, Patient Educ. Couns. 99 (7) (2016) 1079–1086. [PubMed: 26899632]

[56]. DeWalt DA, Malone RM, Bryant ME, Kosnar MC, Corr KE, Rothman RL, et al. , A heart failure self-management program for patients of all literacy levels: a randomized, controlled trial [ISRCTN11535170], BMC Health Serv. Res. 6 (2006) 30. [PubMed: 16533388]

[57]. Jonkman NH, Westland H, Groenwold RH, Ågren S, Atienza F, Blue L, Do self- management interventions work in patients with heart failure? An individual patient data meta-analysis, Circulation 133 (12) (2016) 1189–1198. [PubMed: 26873943]
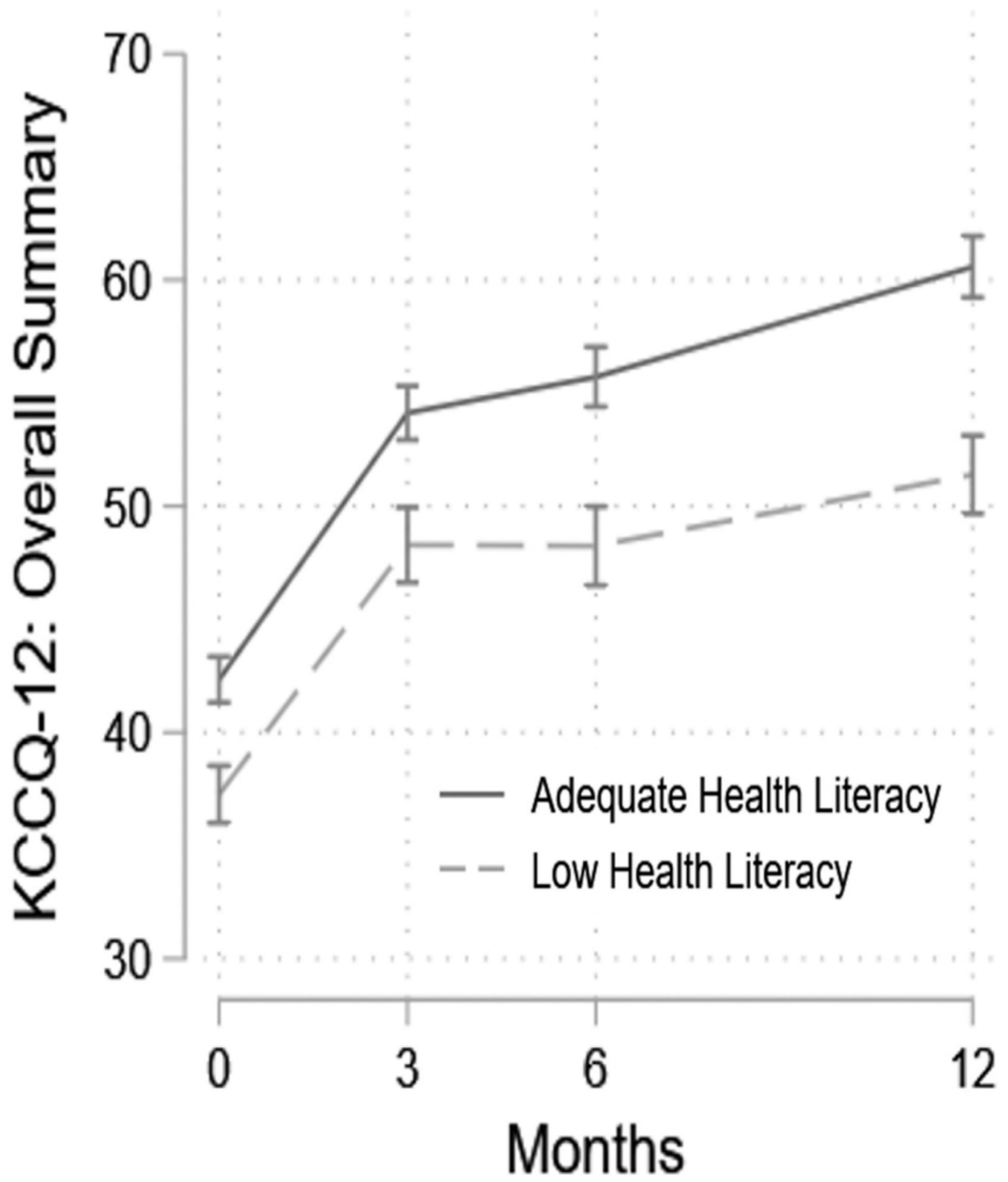
Fig. 1.
Mean unadjusted KCCQ-OS scores over time by health literacy group.

Table 1

Baseline characteristics by health literacy.

	Low HL (N$_1$ = 223)	Adequate HL (N$_0$ = 406)	*p*-Value
Age	64.7 ± 13.5	63.0 ± 12.6	0.126
Female	97 (43 %)	176 (43 %)	0.971
Race			0.656
Non-White	53 (24 %)	103 (25 %)	
White	170 (76 %)	303 (75 %)	
Level of education			<0.001
High school attendee	39 (17 %)	25 (6 %)	
High school graduate	107 (48 %)	136 (33 %)	
College attendee	63 (28 %)	171 (42 %)	
College graduate or higher	14 (6 %)	74 (18 %)	
Employed	13 (6 %)	62 (15 %)	<0.001
Six-Item Cognitive Screen Score			0.001
6 (normal cognition)	128 (57 %)	282 (69 %)	
5	63 (28 %)	99 (24 %)	
4	32 (14 %)	25 (6 %)	
Mean Six-Item Cognitive Screen Score	5.43 ± 0.73	5.63 ± 0.60	<0.001
National area deprivation index percentile	65.7 ± 22.5	67.1 ± 23.7	0.467
Left ventricular ejection fraction	29.7 ± 8.9	27.4 ± 9.4	0.003
NYHA functional class			0.116
Class II	65 (29 %)	148 (36 %)	
Class III	126 (57 %)	215 (53 %)	
Class IV	32 (14 %)	43 (11 %)	
Medications			
ACEi or ARB	126 (57 %)	232 (57 %)	0.877
Beta-Blocker	194 (87 %)	342 (84 %)	0.351
Diuretic	138 (62 %)	263 (65 %)	0.470
Statin	170 (76 %)	269 (66 %)	0.009
Baseline KCCQ overall summary score	37.3 ± 18.8	42.3 ± 20.4	0.002
Baseline PHQ-9 score	14.7 ± 3.7	13.7 ± 3.5	<0.001
History of depression	92 (41 %)	162 (40 %)	0.759
History of CABG	68 (31 %)	109 (27 %)	0.314
History of myocardial infarction	106 (48 %)	179 (44 %)	0.422
Implantable cardiac defibrillator	72 (32 %)	151 (37 %)	0.217
Hypertension	197 (88 %)	343 (85 %)	0.207
Diabetes	121 (54 %)	208 (51 %)	0.486
Stroke	37 (17 %)	51 (13 %)	0.163
Atrial fibrillation	82 (37 %)	170 (42 %)	0.212
Active smoker	55 (25 %)	90 (22 %)	0.487
COPD	76 (34 %)	125 (31 %)	0.397

	Low HL ($N_1 = 223$)	Adequate HL ($N_0 = 406$)	*p*-Value
Chronic kidney disease	65 (29 %)	115 (28 %)	0.800
History of substance abuse	40 (18 %)	77 (19 %)	0.779

Abbreviations: NYHA = New York Heart Association. KCCQ = Kansas City Cardiomyopathy Questionnaire. PHQ-9 = patient health questionnaire (9 items). CABG = coronary artery bypass grafting. COPD = chronic obstructive pulmonary disease. ACEi = angiotensin converting enzyme inhibitor. ARB = angiotensin II receptor blocker.

Table 2

Crude and risk-adjusted differences in KCCQ overall summary scores at baseline and 12-months for low health literacy.

		Model 1 (N = 629) Baseline KCCQ-OS Score (95 % CI)	Model 2 (N = 623) Baseline KCCQ-OS Score (95 % CI)	Model 3 (N = 623) 12-Month KCCQ-OS Score (95 % CI)	Model 4 (N = 466) 12-Month KCCQ-OS Score (95 % CI)
Health literacy groups	Adequate health literacy	Reference	Reference	Reference	Reference
	Low health literacy	−5.07 (−8.3, −1.83) p = 0.002	−5.55 (−8.83, −2.28) p = 0.001	−9.19 (−13.61, −4.77) p < 0.001	−9.79 (−14.26, −5.32) $p < 0.001$
Age			0.18 (0.06, 0.31) p = 0.004		0.15 (−0.02, 0.32) $p = 0.089$
Sex	Male		Reference		Reference
	Female		−1.61 (−4.75, 1.53) $p = 0.314$		0.62 (−3.63, 4.87) $p = 0.774$
Left ventricular ejection fraction			0.09 (−0.08, 0.26) $p = 0.314$		−0.01 (−0.25, 0.22) $p = 0.916$
Area of deprivation index			−0.05 (−0.11, 0.02) $p = 0.195$		−0.09 (−0.19, 0.00) $p = 0.046$
Hopeful heart treatment groups	Overall group effect				$p = 0.538$
	Enhanced usual care group				Reference
	Blended care group				0.64 (−4.07, 5.36) $p = 0.789$
	Usual care group				−2.63 (−8.46, 3.20) $p = 0.376$

Table 3

Risk-adjusted change in KCCQ overall summary scores at 12 months for low health literacy.

		Model 5 (N = 466)
		12-Month KCCQ-OS Score (95 % CI)
Health literacy groups	Adequate health literacy	Reference
	Low health literacy	−6.38 (−10.45, −2.31) p = 0.002
Age		0.04 (−0.12, 0.19) p = 0.622
Sex	Male	Reference
	Female	1.31 (−2.52, 5.13) p = 0.503
Left ventricular ejection fraction		−0.08 (−0.29, 0.13) p = 0.451
Area of deprivation index		−0.07 (−0.15, 0.02) p = 0.115
Hopeful heart treatment groups	Overall group effect	p = 0.432
	Enhanced usual care group	Reference
	Blended care group	0.90 (−3.34, 5.14) p = 0.678
	Usual care group	−2.57 (−7.82, 2.68) p = 0.336
Baseline KCCQ-OS score		0.52 (0.42, 0.61) p < 0.001