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The Association of Health Literacy and Blood Pressure Reduction in a Cohort of Patients with Hypertension: The Heart Healthy Lenoir Trial

Jacqueline R. Halladay, MD, MPH[2,6], **Katrina E. Donahue, MD, MPH**[2,6], **Crystal W. Cené, MD, MPH**[1,6], **Quefeng Li, PhD**[7], **Doyle M Cummings, PharmD**[4], **Alan L. Hinderliter, MD**[1], **Cassandra L. Miller, MPH**[3], **Beverly A. Garcia, MPH**[3], **Edwin Little, MD**[8], **Margorie Rachide, FNP**[8], **Jim Tillman, D. Min**[5], **Alice S. Ammerman, DrPH, RD**[3], and **Darren DeWalt, MD, MPH**[1,6]

[1] Department of Medicine, UNC Chapel Hill, USA

[2] Department of Family Medicine, UNC Chapel Hill, USA

[3] Center for Health Promotion and Disease Prevention, UNC Chapel Hill, USA

[4] Department of Family medicine, East Carolina University, NC, USA

[5] Community Care Plan of Eastern North Carolina, USA

[6] Cecil R. Sheps Center for Health Services Research, Chapel Hill, USA

[7] Department of Biostatistics, UNC Chapel Hill, Chapel Hill, USA

[8] Community Provider, Pink Hill, USA

Abstract

Objective—Lower health literacy is associated with poorer health outcomes. Few interventions poised to mitigate the impact of health literacy in hypertensive patients have been published. We tested if a multilevel quality improvement intervention could differentially improve Systolic Blood Pressure (SBP) more so in patients with low vs. higher health literacy.

Methods—We conducted a non-randomized prospective cohort trial of 525 patients referred with uncontrolled hypertension. Stakeholder informed and health literacy sensitive strategies were implemented at the practice and patient level. Outcomes were assessed at 0, 6, 12, 18 and 24 months.

Corresponding author: Jacqueline R Halladay, MD MPH, Department of Family Medicine, Cecil G. Sheps Center for Health Services Research, The University of North Carolina at Chapel Hill, 590 Manning Drive, Chapel Hill, NC 27599, Phone: 919-843-6607, Fax: 919-966-1634, Jacqueline_halladay@med.unc.edu.

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I confirm that the listed authors have read this manuscript and given their permission for it to be published in PEC.

Results—At 12 months, the low and higher health literacy groups had statistically significant decreases in mean SBP (6.6 and 5.3 mmHg, respectively), but the between group difference was not significant (Δ 1.3 mm Hg, P=.067). At 24 months, the low and higher health literacy groups reductions were 8.1 and 4.6 mm Hg, respectively, again the between group difference was not significant (Δ 3.5 mm Hg, p = 0.25).

Conclusions/practice implications—A health literacy sensitive multi-level intervention may equally lower SBP in patients with low and higher health literacy. Practical health literacy appropriate tools and methods can be implemented in primary care settings using a quality improvement approach.

Keywords

Hypertension; disparities; health literacy; quality improvement; rural health

1. Introduction

Health literacy is defined as the "degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" [1]. Approximately half of American Adults find it difficult to understand and act upon health information and this is magnified in those over age 65 years [1], those with fewer financial resources, and less than a high school education. In addition, African Americans, Hispanics [2], and residents in the South have higher rates of low health literacy [1].

Lower health literacy is associated with higher utilization of healthcare services and poorer health outcomes [3-5] and is an independent predictor of outcomes distinct from educational attainment and other measures of socio-economic status (SES) [3]. Practitioners and health systems can work to mitigate the effects of low health literacy using materials and methods that enhance comprehension for all [1, 6] and target these efforts at various levels of patient influence within the socioecological framework (patient, health system, community) [7]. Helpful strategies include using more oral and visual instructions, engaging patients in interactive educational tools [8-10], and implementing office strategies to improve patient understanding and clinician communication [11].

Intervention trials that used literacy sensitive processes for patients with diabetes, heart failure, and asthma have demonstrated improvements in glycemic control, heart failure associated hospital utilization, disease knowledge and self-management skills [12-16]. In some cases, greater improvements have been demonstrated among those with lower literacy, resulting in a narrowing of disparities in health outcomes [12-14]. However, there are limited data from longer-term longitudinal studies, such as those with outcome data extending beyond one year, where outcomes are compared by literacy level. Few, if any, intervention studies have focused on hypertensive populations [17]. To address these gaps, we assessed the impact of health literacy on mean blood pressure reduction in the Heart Healthy Lenoir (HHL) Study, a multi-level Quality Improvement (QI) intervention to improve blood pressure control in patients cared for in rural primary care practices in Eastern, NC (USA). We hypothesized that our multi-level intervention would have a differential effect by literacy level such that systolic blood pressure (BP) reduction would be greater among those with low literacy at 12 months and that improvements in both groups would be maintained at 24 months.

2.0 Materials and Methods

2.1 Overview

The Heart Healthy Lenoir study was designed to narrow both racial and health literacy disparities in hypertension (HTN) control in rural Eastern North Carolina (USA). We focused on rural Eastern, NC due to the elevated rates of hypertension, cardiovascular morbidity and mortality, noted disparities in HTN prevalence, existing collaborative community and healthcare infrastructure and a commitment of our involved Universities to improve health in economically distressed regions of NC.

2.2 Participating Practices

We identified primary care practices from the area yellow pages. In addition, employees and a hospital Board member at a regional hospital provided practice names. This resulted in a list of eight practices to invite. We sent letters and called the practices to gauge interest. We failed to get response from one practice, two others stated that they were too busy to participate, and one declined due to planned closure. Thus four agreed to participate. We then extended an invitation to a community health center located in a bordering County who accepted. In 2012 a new practice opened and agreed to join. This resulted in six study practices. No primary care practice in the region had any experience in HTN QI.

2.3 Study Design

In the pre-and post-grant award period, our research team spoke with patients, providers, and other community members to understand what would motivate local stakeholders to participate in the study. We learned that the notion of a control group, thus where some practices and patients would not receive direct resources from the study, was not acceptable to patients and providers alike. However, there was great enthusiasm for engaging in in practice level QI. Thus we planned a cohort study using a QI approach.

The study sample included 525 adult English-speaking subjects referred to the study with uncontrolled HTN. Participants were recruited if they had a SBP of 150 mmHg or greater at their most recent healthcare visit, while using a threshold of ≥ 140 mm Hg SBP to define uncontrolled HTN. Practice teams could refer patients directly to the study. Additionally, potential subjects received invitations by phone and mail. The study period was from May 2010 – April 2015.

Focus groups and other stakeholder engagement activities were held in the formative year to adapt and design our intervention [18, 19]. Stakeholders included people representing patients, clinicians, local government, educational systems, faith communities, health advocacy groups and many others.

Throughout the 2.5-year intervention phase, we guided practices to make data driven practice changes for their entire population of patients with HTN (practice level, see Figure

1 and Table 2) and provided additional phone-based health coaching and home blood pressure monitoring for the 525 patients with uncontrolled HTN (patient level, see Figure 1 and Table 3). We collected outcome data on the study participants at 6, 12, 18 and 24 months. As an overarching framework, we reasoned that implementing activities such as 1) enhancing and standardizing team based care, 2) providing patient self-management support (to improve intermediary measures such as patient activation, medication adherence, disease knowledge), 3) facilitating the provision of clinical data to providers [20, 21] and infusing the principles of health literacy throughout, that blood pressure will be lowered. Further details of the trial design, conceptual framework, and methods have been published [18], (Cene C, Journal of Clinical Hypertension, in press).

Using participatory methods, we adapted and created strategies that were feasible, evidence informed, locally relevant and understandable to people of varied health literacy levels. Such strategies included encouraging the use of home BP monitoring (HBPM), having patients and their clinical teams discuss HBPM data at office visits, and asking providers to consider HBPM in their clinical decision making. Additionally, we taught practices to abstract, critically discuss and take action on their HTN control data. We collaboratively created templates and processes to make sure that each patient received standardized care at every visit. We also had quarterly regional dinner meetings that included didactic teaching and role playing activities. Hence, clinical staff learned to 1) motivate patients to change their health behaviors, 2) assess for patient understanding of instructions (teach back), 3) address a limited number of items per visit and 4) engage patients in goal setting. We also conducted educational sessions on health literacy and other topics listed in Table 2.

A subset of patients in the cohort also chose to participate in the community-based lifestyle study where nutrition and physical activity were reinforced for community members who did not need to have HTN or to have a primary care provider to participate [20, 22]. Briefly, the lifestyle study began with a 6-month intervention phase focused on improving dietary fat and carbohydrate quality and increasing physical activity. During the remainder of the 2-year intervention, participants with a BMI ≥ 25 kg/m^2 were invited to take part in a weight loss intervention. Findings from that study, including effects of the lifestyle intervention on SBP have been published [20]. The Biomedical Institutional Review Board at the University of North Carolina at Chapel Hill approved the study and all participants signed informed consent.

2.4 Phone coaching curriculum and supplemental educational handouts (patient level)

We adapted an existing evidence-based phone coaching curricula for use in the study [23]. Two trained phone coaches called each participant once per month for 12 consecutive sessions lasting 15-20 minutes each. Table 3 includes the main topics covered. Further details of the curriculum and coaching process are available [18]. The coaches guided participants in goal setting, reviewed accurate BP measurement technique, and addressed BP target values on each phone call. The investigators worked in collaboration with practice representatives to select relevant self-management support materials that were mailed prior to each coaching session. These materials that were more picture based, included simple language, addressed a limited number of items, and included “white space” for easier review [24, 25]. The resources included text at the 6th to 8th grade reading level [26].

2.5 Study measures

We collected the following information at the enrollment visit: race/ethnicity, insurance status, household income, subjective socioeconomic status (using the MacArthur Scale [27]), highest educational level, use of medications, and multiple other patient and disease oriented outcome measures included in Table 1. The study protocol paper details when the respective data elements were collected [18]. BP was measured by trained research staff using the Omron HEM-907 automated monitor (Omron Healthcare, Inc., Vernon Hills, IL). A research assistant (RA) recorded the average of three sequential measurements obtained at 60-second intervals after the participant was seated for five minutes [28, 29]. Health literacy was measured using the Short-Test of Functional Health Literacy in Adults (STOFHLA), a 36-item, 7-minute timed test of reading comprehension. STOFHLA is a reliable, validated measure of health literacy in the health care context [6, 30]. Each participant's health literacy level was categorized (using standard cut-points) as either inadequate/marginal (0-22 correct answers), which we refer to as low health literacy or higher health literacy (23–36 correct). Weight was measured using a Seca model 770 electronic scale (SECA Corporation, Hanover, MD) and height was measured to the nearest 1/8 inch using a Schorr stadiometer (Schorr Productions, Olney, MD). A trained RA administered all surveys and could read questions aloud if needed.

3.0 Analyses

3.1 Sample size

The sample size calculation was based on the primary aim of the HHL study to compare mean SBP change over 12 months between African American and Whites, and data from prior studies about baseline differences between African Americans and Whites [31]. To assess our power to test differences in SBP changes by literacy, we did not have good data from prior studies. We calculated that a sample size of 520 evenly divided between 2 literacy groups would have 80% power to detect a difference in BP change of 3.5mm Hg. Based on our understanding of the geographic region we were studying and our prior studies in NC, we expected a roughly equal distribution of low and higher literacy participants.

3.2 Analyses

The investigators used descriptive statistics to summarize the sample characteristics overall and by health literacy level using Chi-Square tests for categorical variables and t-tests of continuous variables.

Mean changes in SBP for each group between baseline and 12 months and baseline and 24 months were analyzed using paired t-tests. Crude differences in SBP changes between the two literacy groups were analyzed through independent samples t-tests.

Mean changes in SBP were compared using multivariable regression including a priori planned adjustment for age, BMI, race, and co-enrollment in the lifestyle study. Models were additionally adjusted for other covariates found to be statistically significant at the p<.05 level in our bivariate analyses; restricting the inclusion of these co-variates to those not targeted for change by our intervention.

To avoid overfitting, the multivariate linear regression models, a backward stepwise procedure was used to identify the most influential predictors and the Akaike Information Criterion [32] was used to assess the goodness-of-fit of the regression model. The initial algorithm included all the above covariates together with literacy group indicator in the regression model. At each step, the algorithm removed one covariate and stopped once the AIC reached a minimum value.

The investigators conducted above analyses using the intent-to-treat principle by imputing missing SBP data using the last observation carried forward approach, as well as conducting the analyses on only participants with non-missing outcome data for the time period of interest (“completers only”). As results were qualitatively the same, we report outcomes for completers only. Analyses were conducted using R software, version 3.2.2.

We also explored changes in key intermediary measures as described in section 4.4 below. Mean changes in patient activation, hypertension knowledge, and medication adherence for each group between the two study time intervals were analyzed using paired t-tests. Crude differences in these respective changes between the two literacy groups were analyzed through independent samples t-tests. All three intermediary measures were analyzed as continuous variables (data not shown).

4.0 Results

4.1 Descriptive/ bivariate comparisons

Overall sample: Table 1 describes the sample. Among the 525 participants included in the HHL study, 493 completed the STOHFLA assessment and were included in these analyses. Among these, 23% received a score of ≤ 22, thus categorized as having low health literacy. Fifty-eight percent of the subjects were African Americans and 31% were males. The mean age was 57 (range 20-92) years. The mean BMI and SBP were 36.2 kg/m^2 (SD 9.5) and 138.2 mm Hg (SD 22) respectively. **Literacy group comparisons:** The low health literacy group subjects compared to those with higher literacy were older (64.8 vs. 54.7 yrs, P<.00001), had a higher proportion of males (41% vs. 28%, p <.01) and African Americans (77% vs. 52%, p<0.001). The mean SBP was 144 mm Hg (SD 23) at baseline for those in the low health literacy group compared to 138 mm Hg (SD 21) for those in the higher health literacy group (p<.001). A higher percentage of the low literacy group had health insurance (including Medicaid). Mean weight and BMI was greater in those with higher literacy. Only 6% of the low literacy group had household incomes of ≥40 K. The low literacy group also had a higher mean number of medical co-morbidities. Figure 2 shows participant flow in the study.

4.2 Completers vs. Non-completers

Attendees at the 12-month visit were older and included a higher percentage of African American subjects than those who did not attend (p<.05). At 24 months, attendees, compared to non-attendees, were likewise older, included a higher percentage of African American's, and included a higher percentage of participants classified as having low health literacy.

4.3 Effect of Intervention on Mean Change in SBP at 12 and 24 months

Table 4 reveals the crude and adjusted mean SBP for the two health literacy groups comparing baseline with 12 month and baseline with 24 month outcomes. At 12 months compared to baseline, mean SBP was reduced by 5.6 mm Hg ($p<0.00001$) for the overall sample in unadjusted analyses. Both the low and the higher health literacy groups had statistically significant decreases in mean SBP (6.6 mmHg and 5.3 mmHg, respectively), but the unadjusted difference by health literacy group was not statistically significant (Δ 1.3 mm Hg, $P=.067$). After multi variable adjustment, where our final models included covariates of insurance status, household income, gender, estimated glomerular filtration rate, number of medical co-morbidities, number of classes of anti-hypertensive medications at baseline, subjective social status, and presence of diabetes mellitus, the difference in mean SBP reductions between the literacy groups remained small and statistically non-significant.

At 24 months, the mean SBP decreased by 5.5 mm Hg overall ($p<0.0001$). Those in the lower health literacy group had an 8.1 mm Hg mean SBP reduction ($p=.004$), while the higher health literacy group's mean SBP reduced by 4.6 mm Hg; the unadjusted between group difference was small and not significantly different (Δ 3.5 mm Hg, $p = 0.25$) and multivariate adjustment did not result in substantive differences. Therefore, despite within group improvements, the results did not demonstrate a statistically significant differential reduction in mean BP between the literacy groups at either time point.

4.5 Exploratory analyses on intermediate variables

These data suggest that there were greater absolute gains in patient activation and hypertension knowledge among the lower literacy group, but the between literacy group comparisons were not statistically significant. No statistically significant within group improvements were noted for the medication adherence measure at either study time point. This suggests that improved knowledge and activation in care may have had some influence on the within group BP improvements in our sample.

5.0 Discussion and Conclusions

5.1 Discussion

Our results suggest a practice based multi-level intervention designed using the principles of health literacy can equally help lower SBP in patients with low and higher health literacy for up to two years. Although SBP reduction was not differentially greater in the low health literacy group, a result which would have supported our hypothesis, the between group difference was not increased over time, a phenomenon which has been unexpectedly found in other studies [16, 33].

We credit the success of our intervention to the multi-level approach that guided clinical staff, patients and the health coaches to improve how they communicate with each other. We collaboratively “hard wired” team approaches to care delivery and infused the principles of health literacy throughout the project.

We can directly compare our findings to those from other prospective trials that have examined the effects of interventions on chronic disease outcomes by literacy level. In the context of diabetes, Rothman and colleagues tested the effectiveness of an intensive 12 month, team based, health literacy sensitive disease management program on improving hemoglobin A1C and SBP among patients with HbA1c ≥ 8% who were randomized to an intensive care (n=112) or control arm (n=105) [13]. Among those receiving the intervention, a differential benefit to patients with lower over the higher literacy group was noted (adjusted differences −1.4% p<.001 and −0.5% p=.21, respectively). Although the differences between groups were narrowed over time, this was partly due to a lack of a within group improvement in the higher literacy group. However, similar to our study, the improvements in blood pressure outcomes among their diabetic population were similar in both literacy groups, and a differential reduction in BP was not realized.

DeWalt et al. conducted a randomized controlled trial of 605 patients with heart failure and compared the effectiveness of a single educational session versus a multi session intervention on heart failure hospitalizations and mortality [34]. The authors concluded that a multisession intervention was more effective than a single session intervention in reducing heart failure related hospitalizations in the group with low literacy. Unexpectedly, those with higher literacy seemed to benefit more from the single session, suggesting different intervention intensities may be needed to help patients with different literacy levels.

The failure of the HHL trial to demonstrate a greater reduction in SBP in the low literacy group may be due to a number of factors. Participants were not equally distributed into the two health literacy groups, which increased the probability of making a type 2 error and falsely rejecting the null hypothesis. A much larger sample size would be required to achieve greater statistical power. As well, it is possible that the intervention was truly equally effective in both literacy groups. This notion is supported by our main results, but also by our exploratory analyses on several intermediary outcomes.

5.2 Limitations

Our study's findings should be considered in light of its limitations. First, as a cohort study without a control group for comparisons, there is the chance any observed changes could be due to secular trends, the impact of unmeasured confounders or other factors. However, this design type was a key negotiation with our community stakeholders. Non-randomized observational trial designs are increasingly used for the evaluation of quality improvement and/ or practice-based interventions where rigorous and high fidelity interventions are not feasible or desirable [7, 35].

We suspect that the volunteers for the study represented a relatively healthy group which may have introduced a “healthy volunteer” bias [36-38], a notion supported by the fact our overall mean SBP at baseline was lower than expected. This also introduced a “floor” effect, which limited the amount of SBP reduction that could realistically be made. We do not have data regarding the health literacy levels and blood pressures of any of the 222 people that were invited to participate, but did not respond. As well, several primary practices in the region declined participation. Regarding missing data, 74% of the participants that attended the baseline visit attended the 12-month visit and 71% of those that attended the baseline visit attended a 24-month visit. Despite the amount of missing data, we do not think differences in attendees vs. non-attendees substantively biased our results away from the null, in fact we suspect to the contrary.

The QI nature of our study was both a limitation and a strength. As the intervention included multiple activities implemented simultaneously, we cannot attribute the results to any single element of the intervention. As well, it is possible certain activities were more helpful for one literacy group over another, but in aggregate, the effect was equal. Thus, we are not able to suggest a narrowed menu of activities to use going forward. Additionally, there was variation in the consistency and depth of engagement with the intervention at both the practice and patient level due to staffing turnovers and the competing priorities of practices and patients.

Despite these limitations, our study has strengths. The study had limited exclusion criteria and focused on a rural and impoverished community with a high burden of HTN. We followed participants for 24 months and our data suggest the effects of the 12-month long intervention were sustained. We formally assessed health literacy using a validated tool and infused the principles of health literacy at multiple levels of patient influence. We have numerous other outcomes measures, including genetic data that will be included in subsequent analyses, and may shed further light on the associations of literacy on health outcomes.

5.3 Conclusions

This multiyear QI trial designed for patients with hypertension was successful in reducing mean SBP in adults with both low and higher health literacy levels in rural Eastern, NC. We believe that the success of our program was at least in part due to using effective strategies at multiple levels of patient influence to enhance knowledge and to promote behavior change among care teams and patients alike. It would be considered a success if part of the reason why we didn't see differences in mean SBP reduction between the literacy groups was because the intervention approach and materials were adequately designed and implemented to reach individuals of all literacy levels. We encourage continued work to design pragmatic, multi-level interventions that can further define key strategies that can mitigate the impact of health literacy on patient outcomes.

5.4 Practice Implications

When considering making practice changes to enhance blood pressure control and to reduce risks inherent with sustained uncontrolled HTN, clinicians and staff should work to include the principles of health literacy at multiple levels of patient influence to enhance patient outcomes. Most patients, regardless of literacy level, appreciate a “plain language” approach to both verbal and print communications. Given the complexity and jargon inherent in medical practice, this requires a concerted effort. Our data supports making a commitment to using these principles in office based QI can help people of all levels of health literacy.

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Highlights

- An intervention to reduce Systolic BP is tested for over 2 years in patients with HTN
- Statistically significant Systolic BP reductions were noted at 12 and 24 months, most notably in the low literacy group.
- Implementing health literacy sensitive processes is feasible in practice

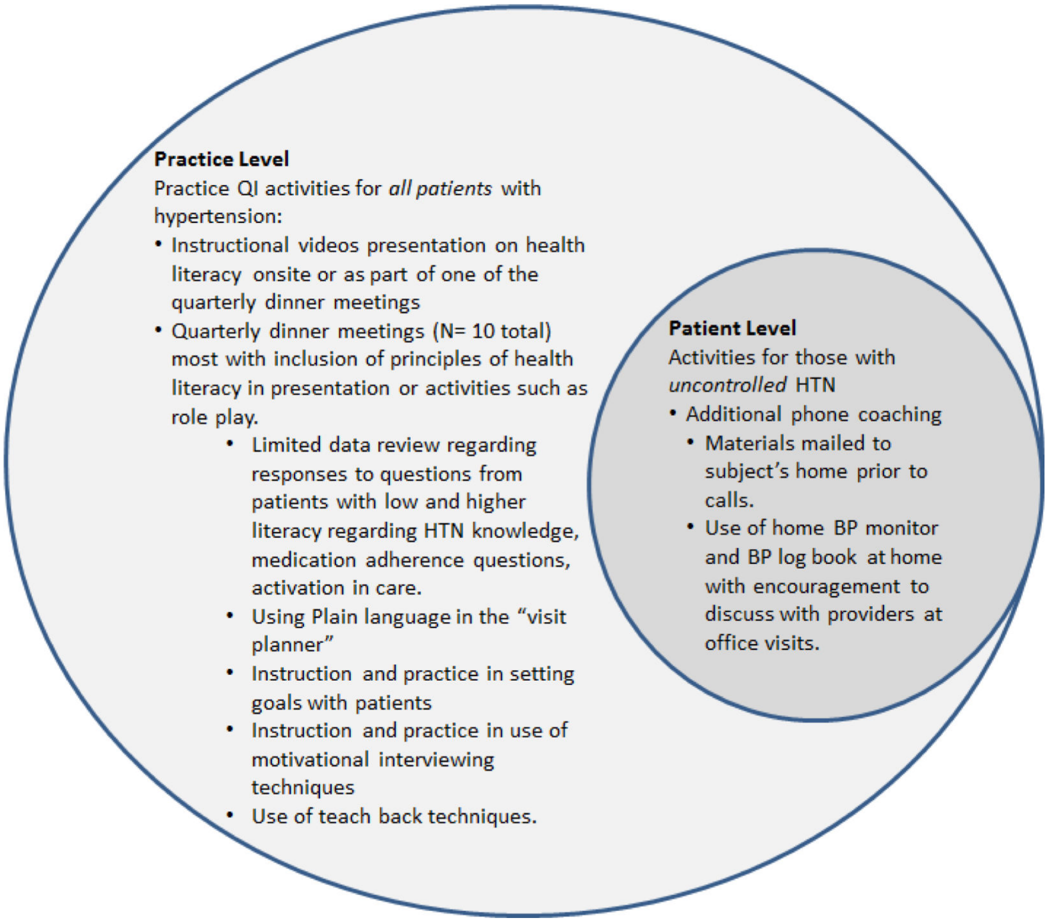
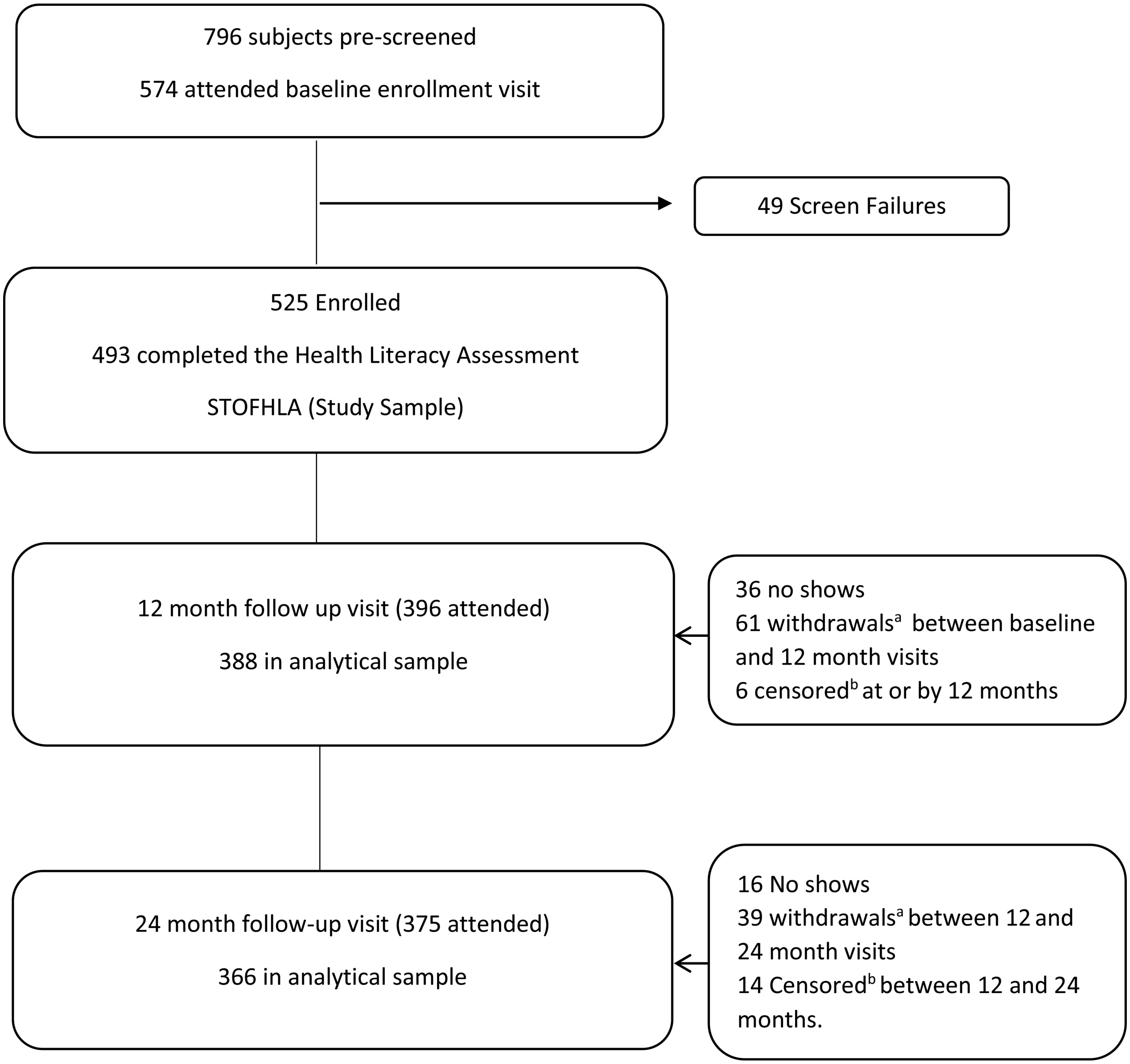


Figure 1.
Health literacy specific practice and patient level activities



[a]Reasons for withdrawal include: patient death, request to no longer participate, moving from the area, lost to follow up, others

[b]Censored = cancer diagnoses, weight loss surgery, pregnancy, thus not included in the analyses

Figure 2.
Participant Flow – Nested Cohort referred to study with uncontrolled HTN

Table 1

Baseline Participant Characteristics

	Overall N = 493	Low Literacy N = 111	Higher Literacy N = 382	*P* value
Characteristics, N (%) unless noted otherwise as standard deviation (SD) or (range)				
Age, mean (range)	57.0 (20-92)	64.8 (30-92)	54.7 (20-83)	P<0.001
Male gender	153 (31%)	46 (41%)	107 (28%)	0.01
African American	284 (58%)	85 (77%)	199 (52%)	P<0.001
Highest grade completed, mean (SD)	12.2 (2.4)	10.8 (2.7)	12.6 (2.1)	P<0.001
Currently have health insurance	366 (74%)	93 (84%)	273 (72%)	0.01
Working full or part time	196 (40%)	25 (23%)	171 (45%)	P<0.001
Household income ≥ 40K	96 (19%)	5 (6%)	91 (27%)	P<0.001
CVD and risk factors for CVD, N (%)				
Diabetes (self report or $HbA_{1c} \geq 6.5$)	211 (43%)	62 (56%)	149 (39%)	P<0.01
Current cigarette smoker (every day or somedays)	112 (23%)	21 (19%)	91 (24%)	0.28
Taking BP lowering medication	438 (89%)	107 (96%)	331 (87%)	P<0.01
Physiologic, mean (SD) unless noted otherwise				
Weight, lbs, (SD)	217 (57.5)	205 (53.8)	220 (58.1)	0.02
BMI (SD)	36.2 (9.5)	34.5 (8.8)	36.7 (9.7)	0.04
Systolic BP, mm Hg (SD)	138.2 (21.6)	144.3 (22.8)	136.5 (20.9)	P<0.001
Diastolic BP, mm Hg (SD)	82.0 (12.9)	79.9 (12.9)	82.6 (12.8)	0.03
Systolic BP ≥ 140 mm Hg	216 (44%)	63 (57%)	153 (40%)	P<0.01
Total cholesterol, mg/dL (SD)	190.3 (41.0)	190.4 (42.9)	190.2 (40.5)	0.58
HDL-C, mg/dL, (SD)	51.9 (15.4)	54.4 (16.3)	51.2 (15.0)	0.06
GFR, mL/min/1.73m^2 (SD)	86.9 (22.8)	78.9 (22.7)	89.2 (22.4)	P<.001
Number of comorbidities (SD)	2.49 (1.9)	2.80 (1.8)	2.40 (1.9)	0.02
Lifestyle study participant	193 (39%)	34 (31%)	159 (42%)	0.05
STOFHLA score = 0-36 (SD)	28.2 (9.7)	12.3 (7.2)	32.8 (3.4)	n/a
Self-rated health good-excellent, N (%)	307 (62%)	73 (66%	234 (61%)	0.45
Comm_Standing (SD)	6.5 (2.3)	6.7 (2.6)	6.5 (2.2)	0.54
US_Standing (SD)	5.5 (2.1)	6.0 (2.5)	5.3 (2.0)	P<0.01
Med_Class_Count (SD)	1.9 (1.3)	2.1 (1.2)	1.8 (1.3)	0.04
Anti-hypertensive medication adherence				
Morisky score (SD)	5.7 (1.4)	5.9 (1.4)	5.7 (1.4)	0.04
Low Morisky score = < 6	177 (36%)	36 (34%)	141 (43%)	0.12
HTN Knowledge score (0-13) (SD)	7.8 (2.8)	6.8 (2.4)	8.1 (2.9)	P<.001
Number of side effects (SD)	2.5 (2.6)	2.3 (2.5)	2.6 (2.6)	0.40
Mental Health Inventory (SD)	72.7 (19.7)	74.7 (18.0)	72.1 (20.1)	0.36
Prescription medications cost/month (SD)	$57 (79.5)	$57 (74.8)	$57 (80.9)	0.89
Patient Activation Measure (SD)	63.1 (15.5)	58.0 (11.5)	64.6 (16.1)	P<0.001

Abbreviations: BMI, body mass index(calculated as weight in kilograms divided by height in meters squared); BP, blood pressure; CVD, cardiovascular disease; HDL-C, high-density lipoprotein; GFR, glomerular filtration rate; HbA_{1C}, hemoglobin A_{1C}; HTN, hypertension; SD, standard deviation; STOFHLA, Short Test of Functional Health Literacy in Adults.

SI unit conversion factors: To convert all types of cholesterol to millimoles per liter, multiply by 0.0259

Table 2

Topics[*] Main practice level activities/topics covered during HHL regional dinner meetings

• Key Drivers of Practice Change/Using population level HTN data to drive change. Using a Key Driver approach to understanding what specific activities within a practice can lead to change [7]
• Implementing a "Visit Planner" for patients at every visit to standardize care. Visit organized using a standardized form and office processes to ensure that key knowledge and behaviors are addressed (BP goals, BP knowledge, use and review of home BP monitoring,)
• Medication Adherence (standardized questions in Visit Planner with skip logic to drive staff to work to better understand and address patient barriers to adherence at the point of care where deficiencies are noted)
• Case studies – Challenging cases and treatment options. Providers and staff communicated about specifically challenging cases to the study team prior to specific dinner meetings such that relevant case specific content was reviewed with the larger group.
• Patient Coaching , Motivational Interviewing, Goal setting (using role play, work guided by trained health coach and research team)
• Health Literacy -as primary focus (review of patient – provider interactions via videos, role play, and review of health literacy literature, work lead by investigator with expertise in health literacy)
• System and office level changes to make to support patients with low literacy – teach back, care coordination, others (role play, group work lead by experienced case manager and investigative team members)

[*]health literacy principles woven into sessions as appropriate. List above demonstrates key themes addressed at dinner meetings and does not imply frequency

Table 3

Main topics covered in phone coaching sessions (monthly 15-17 min calls for 12 months):

• Medication adherence, side effects, strategies to enhance adherence, discussing which medication are specifically for hypertension
• Strategies to enhance dialogue with healthcare providers
• Encouraging physical activity
• Healthy diets - reading food labels; understanding salt reduction, DASH diet, portion control
• Home BP measurement: accurate measurement technique, reviewing recent BP's, addressing BP goals/targets.
• Weight: discussion of relationship of weigh to hypertension
• Addressing social barriers and facilitators to navigate health system and live well
• Stress reductions, coping mechanisms, depression
• Tobacco cessation, Alcohol use

See Halladay BMC HSR 2013 [18] for more details

Table 4

Crude and Adjusted Change in Mean Systolic Blood Pressure (SBP) by Literacy Level

Baseline to 12 Months.

Outcome	**n**	**Baseline SBP mm Hg (SD)**	**12 Month SBP (SD)**	**Mean change within groups: p value**	**Crude: difference between groups: p-value**	**Model 1 adjusted[a] difference between groups: p-value**	**Model 2 adjusted[b] difference between groups: p-value**
Overall	377	138.2 (1.1)	132.6 (1.1)	−5.6 p<0.00001			
Low Literacy	89	143.7 (2.3)	137.1 (2.4)	−6.6 p =.02	Δ 1.3 p=0.67	Δ 2.4 p=0.41	Δ 0.7 p=0.83
Higher Literacy	288	136.4 (1.2)	131.2 (1.2)	−5.3 p<0.0001			

Baseline to 24 Months.

Outcome	**n**		**24 Month SBP (SD)**			**Model 1 Adjusted[c] difference between groups: p-value**	**Model 2 Adjusted[d] difference between groups: p-value**
Overall	355	138.3 (1.1)	132.8 (1.0)	−5.5 p<0.0001			
Low Literacy	90	143.7 (2.3)	135.6 (2.2)	−8.1 P=0.004	Δ 3.5 p=0.25	Δ 0.2 p = 0.94	Δ 0.34 p=0.92
High Literacy	265	136.4 (1.2)	131.8 (1.2)	−4.6 p=0.0006			

low literacy = STOHFLA score of 0-22, higher literacy = STOHFLA score of 23-36

All analyses on respective visit attendees only

[a]Model adjusts for age

[b]Model adjusts for age, co-participation in the lifestyle study, HTN med_class_count, US standing

[c]Model adjusts for age

[d]Model adjusts for age, US_standing