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ORIGINAL RESEARCH

Health Literacy and Medication Understanding Among Hospitalized Adults

CME

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BACKGROUND: Patients' ability to accurately report their preadmission medications is a vital aspect of medication reconciliation, and may affect subsequent medication adherence and safety. Little is known about predictors of preadmission medication understanding.

METHODS: We conducted a cross-sectional evaluation of patients at 2 hospitals using a novel Medication Understanding Questionnaire (MUQ). MUQ scores range from 0 to 3 and test knowledge of the medication purpose, dose, and frequency. We used multivariable ordinal regression to determine predictors of higher MUQ scores.

RESULTS: Among the 790 eligible patients, the median age was 61 (interquartile range [IQR] 52, 71), 21% had marginal or inadequate health literacy, and the median number of medications was 8 (IQR 5, 11). Median MUQ score was 2.5 (IQR 2.2, 2.8). Patients with marginal or inadequate health literacy had a lower odds of understanding their medications (odds ratio [OR] = 0.53; 95% confidence interval [CI], 0.34 to 0.84; $P = 0.0001$; and OR = 0.49; 95% CI, 0.31 to 0.78; $P = 0.0001$; respectively), compared to patients with adequate health literacy. Higher number of prescription medications was associated with lower MUQ scores (OR = 0.52; 95% CI, 0.36 to 0.75; for those using 6 medications vs 1; $P = 0.0019$), as was impaired cognitive function (OR = 0.57; 95% CI, 0.38 to 0.86; $P = 0.001$).

CONCLUSIONS: Lower health literacy, lower cognitive function, and higher number of medications each were independently associated with less understanding of the preadmission medication regimen. Clinicians should be aware of these factors when considering the accuracy of patient-reported medication regimens, and counseling patients about safe and effective medication use. *Journal of Hospital Medicine* 2011;6:488–493. © 2011 Society of Hospital Medicine

With the aging of the US population, complex medication regimens to treat multiple comorbidities are increasingly common.[1] Nevertheless, patients often do not fully understand the instructions for safe and effective medication use. Aspects of medication understanding include knowledge of the drug indication, dose, frequency, and for certain medications, special instructions.[2] Medication understanding is associated with better medication adherence, fewer drug-related problems, and fewer emergency department visits.[3] Among patients with chronic conditions, such as cardiovascular disease (CVD), understanding and adherence to the medication regimen are critical for successful disease control and clinical outcomes.[4]

Patients' understanding of their medication regimen is also vitally important upon admission to the hospital. Patients often are the main source of information for the admission medication history and subsequent medication reconciliation.[5] Poor patient understanding of the preadmission medication regimen can contribute to errors in inpatient and postdischarge medication orders, and adversely affect patient safety.[6] However, little research has examined patients' understanding of the preadmission medication regimen and factors that affect it.

In the outpatient setting, previous investigations have suggested that low health literacy, advanced age, and impaired cognitive function adversely affect patients' understanding of medication instructions.[2,7,8] These studies were limited by a small sample size, single site, or focus on a specific population, such as

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inner-city patients. Additionally, the measures used to assess medication understanding were time-consuming and required patients' medications to be present for testing, thus limiting their utility.[2]

To address these gaps in the literature, we developed and implemented the Medication Understanding Questionnaire (MUQ), an original and relatively rapid measure that does not require patients' medications be present for testing. In a study of adults at 2 large teaching hospitals, we examined the association of health literacy, age, cognitive function, number of preadmission medications, and other factors on patients' understanding of their preadmission medication regimen. We hypothesized that lower health literacy would be independently associated with lower medication understanding as assessed using the MUQ.

METHODS

The present study was a cross-sectional assessment conducted using baseline interview data from the Pharmacist Intervention for Low Literacy in Cardiovascular Disease (PILL-CVD) Study (ClinicalTrials.gov Registration #NCT00632021; available at: http://clinicaltrials.gov/show/NCT00632021). The PILL-CVD Study is a randomized controlled trial of a pharmacist-based intervention, consisting of pharmacist-assisted medication reconciliation, inpatient counseling, low-literacy adherence aids, and postdischarge telephone follow-up. It was conducted at 2 academic medical centers—Vanderbilt University Hospital (VUH) in Nashville, Tennessee, and Brigham and Women's Hospital (BWH) in Boston, Massachusetts.[9] This study was approved by the Institutional Review Board at each site, and all participants provided written informed consent.

Population

The PILL-CVD study protocol and eligibility criteria has been previously published.[9] Briefly, patients were eligible if they were at least 18 years old and admitted with acute coronary syndrome or acute decompensated heart failure. Patients were excluded if they: were too ill to complete an interview; were not oriented to person, place, or time; had a corrected visual acuity worse than 20/200; had impaired hearing; could not communicate in English or Spanish; were not responsible for managing their own medications; had no phone; were unlikely to be discharged to home; were in police custody; or had been previously enrolled in the study. For the present analysis, we also excluded any patient who was not on at least 1 prescription medication prior to admission. Saline nasal spray, saline eye drops, herbal products, nutritional supplements, vitamins, and over the counter (OTC) lotions and creams were not counted as prescription medications. Oral medications available both OTC and by prescription (eg, aspirin, nonsteroidal anti-inflammatory drugs, and acid reflux medications) were counted as prescription medications.

Measures

At enrollment, which was usually within 24 to 48 hours of admission, participants completed the short form of the Test of Functional Health Literacy in Adults (s-TOFHLA) in English or Spanish,[10] the Mini-Cog test of cognition,[11] and the Medication Understanding Questionnaire (MUQ), as well as demographic information. The number of prescription medications prior to hospital admission was abstracted from the best available reference list—that documented by the treating physicians in the electronic health record (EHR). The EHR at each site was a ''home-grown'' system and included both inpatient and outpatient records, which facilitated physicians' documentation of the medication list.

The s-TOFHLA consists of 2 short reading-comprehension passages. Scores on the s-TOFHLA range from 0 to 36, and can be categorized as inadequate (0-16), marginal (17-22), or adequate (23-36) health literacy.[10] The Mini-Cog includes 3-item recall and clock-drawing tests. It provides a brief measure of cognitive function and performs well among patients with limited literacy or educational attainment.[11] Scores range from 0 to 5, with a score <3 indicating possible dementia.

The MUQ was administered verbally and assessed patients' understanding of their own preadmission medication regimen. It was developed for this study, based on published measures of medication understanding.[2,12] To administer the MUQ, research assistants (RAs) accessed the patient's preadmission medication list from the EHR and used a random number table to select up to 5 prescription medications from the list. If the patient was taking 5 or fewer medications, all of their medications were selected. Saline nasal spray, saline eye drops, herbal products, nutritional supplements, vitamins, and OTC lotions and creams were excluded from testing. The RA provided the brand and generic name of each medication, and then asked the patient for the drug's purpose, strength per unit (eg, 20 mg tablet), number of units taken at a time (eg, 2 tablets), and dosing frequency (eg, twice a day). For drugs prescribed on an as-needed basis, the RA asked patients for the maximum allowable dose and frequency. Patients were instructed to not refer to a medication list or bottles when responding. The RA documented the patient's responses on the MUQ, along with the dosing information from the EHR for each selected medication.

One clinical pharmacist (MM) scored all MUQ forms by applying a set of scoring rules. Each medication score could range from 0 to 3. The components of the score included indication (1 point), strength (0.5 point), units (0.5 point), and frequency (1 point).

TABLE 1. Baseline Patient Characteristics

Characteristic	N = 790
Study hospital, N (%)	
Vanderbilt University Hospital	373 (47.2)
Brigham and Women's Hospital	417 (52.8)
Age in years, median (IQR)	61 (52, 71)
Gender, N (%)	
Male	452 (57.2)
Female	338 (42.8)
Primary language, N (%)	
English	779 (98.6)
Spanish	11 (1.4)
Race, N (%)	
White	610 (77.2)
Black or African American	136 (17.2)
Other	44 (5.6)
Health literacy, s-TOFHLA score, median (IQR)	33 (25, 35)
Health literacy, N (%)[&]	
Inadequate	84 (10.6)
Marginal	74 (9.4)
Adequate	613 (77.6)
Mini-Cog score, median (IQR)	4 (3, 5)
Dementia, N (%)	
No	692 (87.6)
Yes	98 (12.4)
Number of medications, median (IQR)	8 (5, 11)
Health insurance type, N (%)	
Medicaid	74 (9.4)
Medicare	337 (42.6)
Private	334 (42.3)
Self-pay	35 (4.4)
Other	10 (1.3)
Self-reported household income, N (%)[&]	
<$10,000	38 (4.8)
$10,000 to <$15,000	45 (5.7)
$15,000 to <$20,000	42 (5.3)
$20,000 to <$25,000	105 (13.3)
$25,000 to <$35,000	99 (12.5)
$35,000 to <$50,000	112 (14.2)
$50,000 to <$75,000	118 (14.9)
$75,000+	227 (28.7)
Years of school, median (IQR)[&]	14 (12, 16)

Abbreviations: IQR, interquartile range; s-TOFHLA, Test of Functional Health Literacy in Adults.
[&] Missing s-TOFHLA, N = 19; missing household income, N = 4; missing years of school, N = 1.

The patient's overall MUQ score was an average of the MUQ scores for each tested medication.

Statistical Analysis

We summarized patient characteristics, number of preadmission medications, and MUQ scores using median and interquartile range (IRQ) for continuous variables, and frequencies and proportions for categorical variables. We conducted proportional odds logistic regression (ordinal regression) to estimate the effect of s-TOFHLA score, other patient characteristics, and number of medications on MUQ scores.[13]

Important covariates were selected a priori based on clinical significance. These included age (continuous), gender, patient self-reported race (white, black, other nonwhite), Mini-Cog score (continuous), primary language (English or Spanish), years of education (continuous), number of preadmission medications (continuous), income (ordinal categories), insurance type (categorical), and study site. Covariates with missing data (household income, health literacy, and years of education) were imputed using multiple imputation techniques.[14] The relationship between number of preadmission medications and MUQ scores was found to be nonlinear, and it was modeled using restricted cubic splines.[14] We also fit models which treated health literacy and cognition as categorical variables. Results are reported as odds ratios (OR) with 95% confidence intervals (CI). Wald tests were used to test for the statistical significance of predictor variables. Two-sided *P* values less than 0.05 were considered statistically significant. All analyses were performed using statistical language R (R Foundation, available at: http://www.r-project.org).

TABLE 2. MUQ Scores and Components at Baseline Among 790 Patients Using at Least 1 Medication

	Median (IQR)
No. of drugs tested	5 (4, 5)
MUQ score*	2.5 (2.2, 2.8)
Indication	1.0 (0.8, 1.0)
Strength	0.2 (0.1, 0.4)
Units	0.5 (0.4, 0.5)
Frequency	1.0 (0.8, 1.0)

Abbreviations: MUQ, Medication Understanding Questionnaire.
*Each medication score could range from 0 to 3. For each medication tested, the components of the score included indication (1 point), strength (0.5 point), units (0.5 point), and frequency (1 point). The patient's overall MUQ score was then the average of the MUQ scores for each medication.

RESULTS

Baseline Characteristics

Among the 862 patients enrolled in PILL-CVD, 790 (91.7 %) had at least 1 preadmission medication and were included in this analysis (Table 1). Forty-seven percent were admitted to VUH (N = 373) and 53% to BWH (N = 417). The median age was 61 (interquartile range [IQR] 52, 71), 77% were white, and 57% were male. Inadequate or marginal health literacy was identified among 11% and 9% of patients, respectively. The median number of preadmission medications was 8 (IQR 5, 11). Patients excluded from the analysis for not having preadmission medications were similar to included patients, except they were more likely to be male (76% vs 57%) and less likely to have health insurance (23% self-pay vs 4%). (Data available upon request.)

MUQ Scores

The MUQ was administered in approximately 5 minutes. The median MUQ score was 2.5 (IQR 2.2, 2.8) (Table 2); 16.3% of patients scored less than 2. Subjects typically achieved high scores for the domains of indication, units, and frequency, while scores on the strength domain were lower (median = 0.2 [IQR 0.1, 0.4], maximum possible = 0.5).

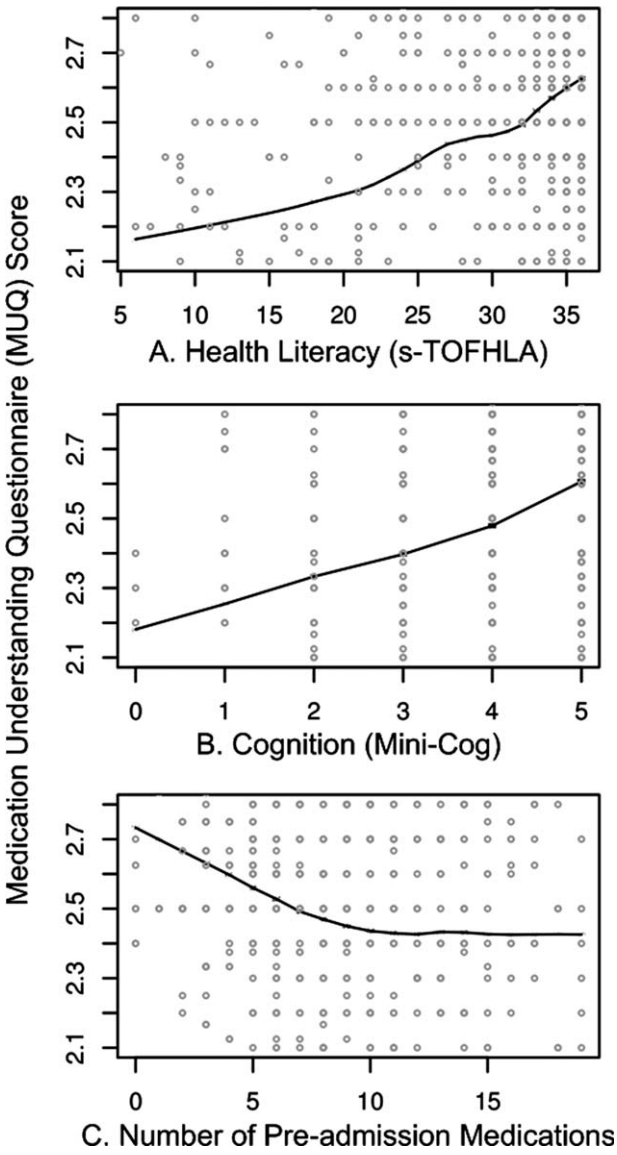

FIG. 1. Unadjusted relationships of Medication Understanding Questionnaire (MUQ) scores with: (A) health literacy, (B) cognition, and (C) number of preadmission medications. **Abbreviations**: s-TOFHLA, Test of Functional Health Literacy in Adults.

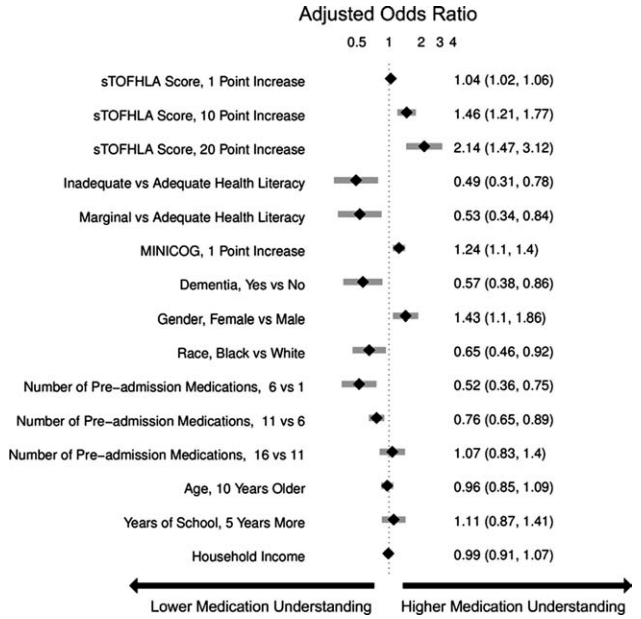

FIG. 2. Forest plot of the adjusted odds of a higher Medication Understanding Questionnaire (MUQ) score compared to an average patient. Odds ratios (OR) of <1 represent lower medication understanding; OR of >1 represent higher medication understanding. Model includes: age, gender, patient self-reported race, Test of Functional Health Literacy in Adults (s-TOFHLA) score, cognitive function, primary language, years of education, number of preadmission medications (nonlinear restricted cubic spline with 3 knots), income, insurance type, and study site. Diamonds represent point estimate, and shaded gray bars represent 95% confidence intervals.

Predictors of Medication Understanding

Unadjusted relationships of health literacy, cognition, and number of medications with medication understanding are shown in Figure 1 (panels A, B, and C, respectively). The figure demonstrates a linear relationship with both health literacy (Figure 1A) and cognition (Figure 1B), and a nonlinear relationship between number of preadmission medications and MUQ score (Figure 1C).

Adjusted relationships using imputed data for missing covariates are shown in Figure 2. Lower health literacy, cognitive impairment, male gender, and black race were independently associated with lower understanding of preadmission medications. Each 1 point increase in s-TOFHLA or Mini-Cog score led to an increase in medication understanding (OR = 1.04; 95% CI, 1.02 to 1.06; $P = 0.0001$; and OR = 1.24; 95% CI, 1.1 to 1.4; $P = 0.001$; respectively). Patients with marginal or inadequate health literacy had lower odds of understanding their regimen (OR = 0.53; 95% CI, 0.34 to 0.84; and OR = 0.49; 95% CI, 0.31 to 0.78, respectively) compared to those with adequate health literacy. Impaired cognitive function (Mini-Cog score <3, indicating dementia) was also associated with lower odds of medication understanding (OR = 0.57; 95% CI, 0.38 to 0.86) compared to those with no cognitive impairment. An increase in the number of preadmission medications (up to 10) was also strongly associated with lower MUQ scores. For each increase by 1 medication, there was a significant decrease in medication understanding, up to 10 medications, beyond which understanding did not significantly decrease further. Patients on 6 medications were about half as likely to understand their medication regimen as patients on only 1 medication (OR = 0.52; 95% CI, 0.36 to 0.75). For patients on 11 medications, the odds of medication understanding were 24% lower than for patients on 6 medications (OR = 0.76; 95% CI, 0.65 to 0.89). Patients' age, years of schooling, and household income were not independently associated with medication understanding. Results were similar using data without multiple imputation.

Examples of Misunderstanding of Common Medications

Table 3 provides examples of incorrect patient responses for several commonly prescribed

TABLE 3. Common Incorrect Responses for Frequent Medications and Resulting Error Code on MUQ

Medications	Common Incorrect Responses	Correct Information	Coded Error
Aspirin	½ tablet twice a day	1 tablet once a day	Units and frequency
	I am not aware what aspirin I am taking	81 mg once a day	Strength
	I am taking 6-something every day	81 mg once a day	Strength
	31 mg a day	81 mg once a day	Strength
	180 mg a day	81 mg once a day	Strength
	1 low-dose daily	325 mg once a day	Strength
	125 mg a day	325 mg once a day	Strength
	I am taking it for my blood pressure	Heart medication	Indication
Nitroglycerin sublingual	As needed, I have taken up to 4 a day	Dissolve 1 tablet under the tongue, every 5 min as needed, up to 3 doses	Frequency
	As needed every 15 min		Frequency
	As needed up to 4 doses every 10 min		Frequency
	Dissolve couple units under the tongue, as needed		Units and frequency
	As many as I want, every 5 min		Frequency
Digoxin	½ tablet daily	1 tablet daily	Units
	1 tablet daily	1 tablet every other day	Frequency
	I am taking it for my blood pressure	Heart medication	Indication
HMG-CoA reductase inhibitors	1 tablet every morning	1 tablet every evening	Frequency
	½ tablet twice a day	1 tablet once a day	Units and frequency
	I do not know the indication	High cholesterol	Indication
Propoxyphene/acetaminophen	½ tablet as needed	1 tablet every 4-6 hr as needed	Units and frequency
Hydrocodone/acetaminophen	I do not know the strength of this medication	5 mg/500 mg	Strength
	1 tablet as I need it	1 tablet every 4-6 hr as needed	Frequency

Abbreviations: MUQ, Medication Understanding Questionnaire.

medications or drug classes, including aspirin, digoxin, nitroglycerin, and HMG-CoA reductase inhibitors (statins). For aspirin, many patients were not aware of the strength. For digoxin, several participants reported splitting a higher-strength pill to obtain the prescribed dose, which should not be done given the imprecision of splitting and narrow therapeutic index of this drug. Patients prescribed nitroglycerin sublingual tablets were commonly unable to report the correct dosing and frequency for angina treatment. Medications for cholesterol were often reported as being taken in the morning; this was scored strictly as a frequency error if the medication timing in the EHR was listed as evening or bedtime. We also identified many patients with poor understanding of opioid analgesics, particularly regarding their dosing and frequency.

DISCUSSION

We used a novel four-component medication understanding questionnaire, developed for this study, to assess patients' understanding of up to 5 drugs selected randomly from the participant's preadmission medication list. The MUQ proved to be easy to administer by nonmedical staff within a short period of time (approximately 5 minutes per patient). It was well understood by patients. By limiting the assessment to 5 or fewer medications, the MUQ has a distinct advantage over existing measures of medication understanding that require testing the entire regimen. We did not find any limitations related to cutting off the assessment at 5 medications. In addition, this tool affords assessment of medication understanding without requiring medication bottles be present, enhancing its utility in the inpatient setting.

MUQ scores were associated with health literacy and other patient characteristics in an expected manner. We demonstrated that inadequate or marginal health literacy, as well as impaired cognitive function, were associated with low medication understanding. We also were able to demonstrate a relationship between increasing number of medications and lower medication understanding. Interestingly, in our patient population, understanding continued to decrease until reaching 10 medications, beyond which further increases in the number of medications had no additional detrimental effect on medication understanding. This nonlinear relationship between number of medications and medication understanding has potential implications for prescribing practice.

Our findings which utilize the MUQ among inpatients are consistent with prior literature in other settings.[2,7,8] In a previous outpatient study, we identified that health literacy plays an important role in a patient's ability to successfully report and manage their daily medications.[2] Other studies have also shown that patients with low health literacy have more difficulty understanding prescription drug information, and that they often experience medication-related problems after hospital discharge.[15,16] The number and often the types of medications an individual takes have also been shown to increase the risk for adverse events and nonadherence to the treatment plan.[17–20] We postulate that this risk of adverse drug events is related at least in part to a patient's understanding of their medication regimen.

There are several limitations to this study. First, the MUQ did not assess certain aspects of medication understanding, such as knowledge of pill appearance or side effects, nor did it assess components of patients' actual drug-taking behavior, such as organization of medications or behavioral cues. Thus, adaptive behaviors that patients may perform to improve their medication management, such as writing on labels or memory cues, are not captured by this test. Second, in administering and scoring the MUQ, we used the patient's preadmission medication list documented in the EHR as the reference standard. This was the best available reference list, and was generally accurate, as both hospitals had medication reconciliation systems in use at the time of the study[21]; nevertheless, it may contain inaccuracies. Documentation for certain medications, such as warfarin, in which dose can change frequently, often did not reflect the latest prescribed dose. In such cases, we scored the patient's answer as correct if the dose appeared reasonable and appropriate to the clinical pharmacist. As a result, a patient's MUQ score may have been overestimated in these cases.

Additional research will be needed to further validate the MUQ in other settings. In particular, studies should establish the relationship between the MUQ, serious medication errors after discharge, and potential to benefit from educational interventions. Also, as noted above, the nonlinear relationship between number of medications and medication understanding should be confirmed in other studies.

In conclusion, we demonstrated that patients with low health literacy, impaired cognition, or a higher number of medications had significantly poorer understanding of their preadmission medication regimen. These findings have important clinical implications. It would be appropriate to exercise greater caution when taking a medication history from patients who cannot readily provide the purpose, strength, units, and frequency of their medications. Attempts to validate the information obtained from patients with other sources of data, such as family members, inpatient or outpatient health records, and community pharmacy records should be considered. Patients at high risk for poor medication understanding, either measured directly using the MUQ or identified via risk factors such as polypharmacy, low cognition, or low health literacy, may warrant more intensive medication reconciliation interventions and/or educational counseling and follow-up to prevent postdischarge adverse drug events. Further research is needed to determine if targeting these populations for interventions improves medication safety during transitions in care.

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