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Development of a brief test to measure functional health literacy

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Abstract

We describe the development of an abbreviated version of the Test of Functional Health Literacy in Adults (TOFHLA) to measure patients' ability to read and understand health-related materials. The TOFHLA was reduced from 17 Numeracy items and 3 prose passages to 4 Numeracy items and 2 prose passages (S-TOFHLA). The maximum time for administration was reduced from 22 minutes to 12. In a group of 211 patients given the S-TOFHLA, Cronbach's alpha was 0.68 for the 4 Numeracy items and 0.97 for the 36 items in the 2 prose passages. The correlation (Spearman) between the S-TOFHLA and the Rapid Estimate of Adult Literacy in Medicine (REALM) was 0.80, although there were important disagreements between the two tests. The S-TOFHLA is a practical measure of functional health literacy with good reliability and validity that can be used by health educators to identify individuals who require special assistance to achieve learning goals.

Keywords: Educational status; Socioeconomic factors; Patient education; Questionnaires

1. Introduction

In 1993, the National Adult Literacy Survey reported that over 40 million adult Americans were functionally illiterate, meaning they could not perform the basic reading tasks necessary to function fully in society [1]. Another 50 million had marginal reading skills [1]. When these individuals encounter the health care system, they are likely to have significant difficulties with routine reading requirements, such as reading prescription bottles, appointment slips, self-care instructions, and health education brochures [2–16]. It is important to be able to identify people with limited reading ability so they can receive special instructions regarding medications and chronic disease management (e.g. glucose monitoring for patients with diabetes).

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The Test of Functional Health Literacy in Adults (TOFHLA) was designed to measure patients' ability to read and understand the things they commonly encounter in the health care setting using actual materials like pill bottles and appointment slips (i.e. health literacy) [17]. Previous tests of reading ability such as the Rapid Estimate of Adult Literacy in Medicine (REALM) measure only the ability to read and correctly pronounce a list of words. The TOFHLA is a more accurate indicator of a patient's reading ability because it measures *comprehension*, including the ability to read and understand both prose passages and numerical information. In a study conducted at two public hospitals using the TOFHLA, one third of English-speaking patients were unable to read the most basic health-related materials, and the prevalence of inadequate literacy was markedly higher among the elderly [2].

Other studies have shown that patients with inadequate functional health literacy as measured by the TOFHLA have less knowledge about chronic diseases and self-management, suggesting that current educational strategies are less successful for this group. Despite having an equal number of diabetes education classes, patients with inadequate functional health literacy were less likely to know basic facts about their disease (e.g. range for a normal blood sugar, symptoms of hypoglycemia) or elements of their care plan (e.g. what to do if they developed symptoms of hypoglycemia) [18]. Similarly, patients with hypertension and inadequate functional health literacy were less likely to know basic information about hypertension (e.g. what a normal blood pressure is) and less likely to know what foods had high sodium content [18]. Screening patients with chronic disease prior to educational programs can identify those with inadequate functional health literacy. Providing special assistance to these patients may improve their ability to manage their medical conditions.

Although the original TOFHLA is an effective tool for identifying patients who have inadequate functional health literacy, it takes up to 22 minutes to administer. We therefore developed the short TOFHLA (S-TOFHLA) by reducing the TOFHLA from 17 Numeracy items (e.g. prescription bottles, appointment slips) and 3 prose passages to a version containing 4 Numeracy items and 2 prose passages. The maximum time for administration was reduced from 22 minutes to 12 minutes. This paper describes the development of the S-TOFHLA, its reliability and validity compared to the REALM, and the S-TOFHLA's usefulness for identifying patients with inadequate functional health literacy.

2. Methods

2.1. Selection of numeracy items and reading comprehension passages for the S-TOFHLA

The original TOFHLA consists of two sections: a 50-item Reading Comprehension test and a 17-item Numeracy test. The Reading Comprehension test has three health-related passages (Gunning FOG readability 4.3, 10.4, and 19.5, respectively). Each passage has every 5th to 7th word deleted; for each blank, the respondent must select from a list of four words the one that best completes the sentence (modified Cloze procedure) [19]. The Numeracy test assesses quantitative literacy needed in the health-care setting (i.e. the ability to read and understand numerical information in the form of prescription bottles, appointment slips, or other health-related materials). Patients are given cue cards or bottles to read (e.g. the directions for taking medication) and then orally asked questions about the information. The Numeracy items have an average readability of 9.4 according to the Gunning FOG. The 17-items are weighted to yield a Numeracy score of 50, which gives a total of 100 possible points for the total TOFHLA when added to the 50 Cloze items. The TOFHLA is available in both an English and a Spanish version, each with regular and large-font print (for patients with visual acuity between 20/70 and 20/100).

Item selection for the S-TOFHLA was based on data from a large previous study that used the TOFHLA [2]. For the Reading Comprehension portion, we included 2 passages with a total of 36 Cloze items: preparation for an upper gastrointestinal series (4th grade level) and the patient rights and responsibilities section of a Medicaid application (10th grade level).

Numeracy items were selected based upon the perceived importance and frequency of the task in

the health care setting, the proportion of patients who answered items incorrectly, and the perceived ease of administration. Five Numeracy items were selected from the original 17 items in the TOFHLA. One item was dropped after initial testing showed that it had poor correlation with the other items, leaving four Numeracy questions for the final version (see appendix for Numeracy items and an example of the Reading Comprehension passages).

2.2. Study population and initial testing of the S-TOFHLA

Testing was conducted in the Urgent Care Center and Medical Clinic at Grady Memorial Hospital, an urban public hospital in Atlanta, GA which primarily cares for indigent African-American residents of Fulton and DeKalb counties. This is the same setting used for development and testing of the TOFHLA. The study design and contact forms were approved by the hospital human investigations committee. Patients were enrolled during a four week period in January and February of 1997. Exclusion criteria were age less than 18 years, unintelligible speech, overt psychiatric illness, lack of cooperation, native language other than English, and being too ill to participate. A convenience sample of patients was enrolled on weekdays from the Medical Clinic and from weekdays, evenings and weekends in the Urgent Care Center. To diminish selection bias, patients were enrolled sequentially from the medical charts of patients waiting to be seen. We introduced the study to patients by saying we wanted to find out what health care information is understood by patients and what is confusing to them, with the goal of helping us write things more clearly. Patients were not told that their reading ability would be tested.

After obtaining informed consent, we interviewed patients to collect information about demographics and self-reported health status. Visual acuity was then determined using a pocket vision screener (Rosenbaum, Graham-Field Surgical Co, Inc, New Hyde Park, NY). Patients with vision worse than 20/100 were excluded. Those with visual acuity between 20/70 and 20/100 were given a large print (14 point font) version of the S-TOFHLA, and all others were given the standard version (12 point font). Following the S-TOFHLA, patients were administered the Rapid Estimate of Adult Literacy in Medicine (REALM) [20]. The REALM requires 1 to 3 minutes to administer; patients read aloud from a 66-item list of medical terms arranged in increasing order of difficulty, and one point is scored for each word that is pronounced correctly. The REALM assigns patients to one of four reading grade range estimates: (1) 3rd grade and below, (2) 4th to 6th grade, (3) 7th to 8th grade, and (4) 9th grade and above.

Internal consistency for the 4 Numeracy items and the 36 Cloze items in the S-TOFHLA was determined using Cronbach's alpha. The correlation between the REALM and total scores for the S-TOFHLA, the total score for the Numeracy items, and the total score for the Cloze items was assessed with the Spearman correlation coefficient.

2.3. Establishing a scoring system for the S-TOFHLA

A scoring system for the S-TOFHLA was created using data from the same large previous study of the TOFHLA used for item selection [2]. To determine weights for individual items in the S-TOFHLA, linear regression was performed using the Numeracy items and the total score on the Reading Comprehension passages as independent variables and the total TOFHLA score as the dependent variable. We then used the coefficients from the linear regression equation (with rounding to the nearest integer to facilitate scoring) to develop scores for each item and an overall scoring system for the S-TOFHLA. All analyses were performed using STATA (version 5.0; College Station, Texas).

Because of the differences between the TOFHLA and the S-TOFHLA, new cutoffs for inadequate and marginal functional health literacy needed to be established. To do this, we determined which cutoffs for the S-TOFHLA resulted in proportions of patients with inadequate and marginal literacy that most closely matched the proportions expected based upon the original study of the full TOFHLA [17]. First, we stratified patients in the original study into categories according to their age (18–30, 31–45, 46–60, and >60 years old) and the number of years of school completed (0–6, 7–11, 12, >12); age and years of school completed are the strongest predic-

tors of functional health literacy. For each of the resulting 16 age-education cells (i.e. each cell in a 4×4 table of age versus years of school completed), we determined the proportion of patients who had inadequate and marginal literacy according to the TOFHLA. This defined the *expected proportions* of patients for each cell with inadequate and marginal literacy to be used as the ''gold standard'' to establish cutoffs for the S-TOFHLA.

Next, the 211 patients tested with the S-TOFHLA were also stratified according to age and the number of years of school completed using the same categories described above. We then calculated the *observed proportions* of patients with inadequate literacy for each cell at a range of possible cutoffs for inadequate literacy (i.e. 50 to 60). To see which cutoff resulted in the least difference between the *observed* and the *expected proportions* of patients with inadequate literacy across all 16 of the age/education cells, we computed a chi-square goodness-of-fit statistic for known cell probabilities [21]. The scoring cutoff that resulted in the minimum value for this statistic (indicating the least difference between the observed and the expected proportions of patients with inadequate literacy) was used to define the upper boundary for inadequate literacy for the S-TOFHLA. The same procedure was then repeated to define the upper boundary for marginal literacy. Any patient with a score above the upper boundary for marginal literacy was classified as having adequate literacy. Through this technique, scoring categories for the S-TOFHLA were created that were as similar as possible to the original TOFHLA.

To compare the categorical classifications for the S-TOFHLA (adequate, marginal, and inadequate) with the categories for the REALM (levels 1–4), the Spearman rank correlation coefficient was used.

3. Results

3.1. Numeracy and reading comprehension scores for the S-TOFHLA

For the testing of the S-TOFHLA, 283 patients were approached. A total of 35 (13%) were not eligible. Of the 248 eligible patients, 30 (12%) refused to participate, and 7 (3%) initiated but failed to complete the survey, leaving 211 (85%) patients who completed the survey. For the patients who completed the survey and the literacy test, the average age was 44 years old, 53% were female, 94% were African American; 42% did not complete high school, 27% completed high school, and 31% had some education beyond high school. The proportions of patients who correctly answered Numeracy items and scores for the Reading Comprehension passages are shown in Table 1. A total of 52% correctly answered 2 or fewer Numeracy items, 23% answered 3 items correctly, and 25% answered all 4 items correctly. For reading passage A, 19% correctly completed 8 or less of the 16 Cloze items. For reading passage B, 44% correctly completed 10 or less of the 20 Cloze items.

The S-TOFHLA showed good internal consistency. For the 4 Numeracy items, the Cronbach's alpha was 0.68, and for the 36 Cloze items in the reading comprehension section the Cronbach's alpha was 0.97. The correlation between the Numeracy score and the reading comprehension score was 0.60.

Table 1
Proportion of patients answering Numeracy items correctly, and scores on the two reading passages for the S-TOFHLA

	Correct (%)
Numeracy items	
Take medication every 6 hours	56
Normal blood sugar	56
Appointment slip	59
Take medication on empty stomach	53
Numeracy items completed correctly	(%)
0	17
1	15
2	20
3	23
4	25
Number correct on reading passages[a]	(%)
A – Preparation for an upper GI	
0–8	19
9–12	11
13–16	70
B – Medicaid rights and responsibilities	
0–10	44
11–15	8
16–20	48

[a] Passage A is written at a 4th grade level, and passage B is written at a 10th grade level.

3.2. Scoring system for the S-TOFHLA

Using data from the original TOFHLA development studies, we determined regression coefficients for the S-TOFHLA items in a linear regression model with the full TOFHLA score as the dependent variable. The coefficients for the Numeracy items ranged from 4.9 to 9.0 (Table 2). To facilitate scoring of the S-TOFHLA, we used the average coefficient for the Numeracy items as the score for each of the Numeracy items. Thus, each of the 4 Numeracy items was assigned a score of 7 points, giving a total of 28 possible points for the Numeracy section. Similarly, the coefficient for the reading comprehension section in the linear regression equation was used to assign a score of 2 points to each of the 36 Cloze items. Thus, the maximum possible score for the reading comprehension section was 72. The total score for the S-TOFHLA is therefore 100, the same as for the original TOFHLA.

We established new cutoffs for the S-TOFHLA by determining which cutoffs resulted in age and education-stratified frequency distributions of inadequate and marginal literacy that most closely matched the frequency distributions expected based upon the original study using the full TOFHLA (see Section 2.3) [17]. The cutoffs that best fit the expected distributions for the age and education were inadequate, 0–53; marginal, 54–66; and 67–100, adequate. The *P* values for the goodness of fit were 0.50 for inadequate literacy and 0.12 for marginal literacy, indicating an acceptable fit with the expected distribution.

Based on these cutoffs, 34% of patients had inadequate literacy, 12% were marginal, and 54% had adequate literacy (Table 3). The proportion of patients with inadequate literacy increased dramatically with age, ranging from 8% of patients age 18 to 30 up to 86% of patients greater than 60 years old (Table 3). The number of years of school completed was only moderately associated with functional health literacy (Table 3; Spearman's correlation coefficient 0.56). Almost all patients (82%) who completed 8 years of school or less had inadequate functional health literacy, and almost all (91%) patients with education beyond high school had adequate functional literacy. However, for other patients the years of school completed were weakly associated with actual functional health literacy. Of

Table 3
S-TOFHLA results according to age and years of school completed[a]

	N	Literacy category (*N*, %)		
		Inadequate	Marginal	Adequate
Age (years)				
18–30	40	3 (8)	3 (8)	34 (85)
31–45	87	15 (17)	11 (13)	61 (70)
46–60	49	23 (47)	8 (16)	18 (37)
>60	35	30 (86)	3 (9)	2 (6)
School (years)				
0–8	28	23 (82)	4 (14)	1 (4)
9–11	62	29 (47)	10 (16)	23 (37)
12	77	17 (22)	9 (12)	51 (66)
>12	44	2 (5)	2 (5)	40 (91)
Total	211	75 (34)	21 (12)	115 (54)

[a] Numbers in parentheses may not add to 100% due to rounding.

Table 2
Coefficients for the S-TOFHLA items in a linear regression model with the TOFHLA score as the dependent variable, and final scoring weights assigned to each item for the S-TOFHLA

	Coefficient (+SE)	S-TOFHLA scoring[a]
Numeracy items		
Take medication every 6 hours	9.0 (+0.6)	7
Normal blood sugar	6.8 (+0.5)	7
Appointment slip	5.9 (+0.6)	7
Take medication on empty stomach	4.9 (+0.5)	7
Cloze passages		
Total score (range 0–36)	1.8 (+0.3)	2 each (72 total)

[a] Total points add to 100.

those who entered high school but did not complete it (grades 9 to 11), 37% had adequate literacy (Table 3). Conversely, among high school graduates, 22% had inadequate literacy and another 12% had marginal literacy.

3.3. Comparison of the S-TOFHLA and the REALM

The correlation between the S-TOFHLA and the REALM was 0.80. For the subscores of the Numeracy and the Cloze sections, correlations with the REALM were 0.61 and 0.81, respectively. All correlations were significant at $P < 0.001$. However, there were important differences between the S-TOFHLA and the REALM in the mid-range of test scores (Fig. 1); for patients in the 25–75% interquartile range for the S-TOFHLA (42 to 91), the correlation between the S-TOFHLA and the REALM was 0.62.

We then compared the S-TOFHLA to the REALM using the three S-TOFHLA categories (adequate, marginal, and inadequate) and the four categories for the REALM: level 1 (grade 3 or less), level 2 (grade 4–6), level 3 (grade 7–8), and level 4 (grade 9 or higher). The Spearman rank correlation coefficient for scores on the two tests was 0.73. However, the categories for the S-TOFHLA and the REALM showed important differences. Of the 75 patients who were classified as level 3 (grade 7–8) by the REALM, 11 (15%) were classified as having inadequate literacy and another 8 (11%) were classified as having marginal literacy by the S-TOFHLA (Table 4). In addition, of the 49 patients classified as level 2 (grade 4–6), 9 (18%) were classified as having adequate literacy by the S-TOFHLA.

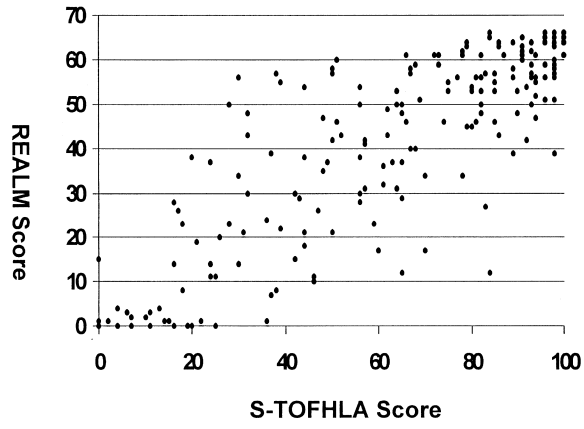

Fig. 1. Comparison of patients' scores on the Rapid Estimate of Adult Literacy in Medicine (REALM) and the Short Test of Functional Health Literacy in Adults (S-TOFHLA). The REALM score ranges from 0 to 66, and the S-TOFHLA score ranges from 0 to 100.

4. Discussion

4.1. Reliability, validity, and practicality of the S-TOFHLA

The S-TOFHLA appears to have good reliability (internal consistency), and it is a valid measure of patients' ability to read the materials they are likely to encounter in the health care setting (i.e. health literacy). Further testing in a larger, more diverse population is needed to confirm this high reliability. The correlation between the S-TOFHLA and the REALM (0.80) was only slightly lower than the correlation between the TOFHLA and the REALM in the original development study (0.84) (17). Thus, the S-TOFHLA has similar reliability and validity to

Table 4
Comparison of patients' health literacy according to the S-TOFHLA and the REALM (*N*, %)[a]

Realm classification (score range)	*N*	S-TOFHLA classification (score range)		
		Inadequate (0–53) (*N* = 71)	Marginal (54–66) (*N* = 25)	Adequate (67–100) (*N* = 115)
Level 1 (0–18)	38	34 (89%)	2 (5%)	2 (5%)
Level 2 (19–44)	49	26 (53%)	14 (29%)	9 (18%)
Level 3 (45–60)	75	11 (15%)	8 (11%)	56 (75%)
Level 4 (61–66)	49	0 (0%)	1 (2%)	48 (98%)

[a] Numbers in parentheses may not add to 100% due to rounding.

the full TOFHLA but is more practical because it requires a maximum time of 12 minutes to complete instead of 22. Although the average time of administration will vary according to a populations' reading ability, the average time of administration for most groups should be substantially less than 10 minutes. In addition, the Numeracy items selected for the S-TOFHLA are easier to administer than the full battery of questions in the TOFHLA, and scoring correct answers is less subjective.

These results also suggest it may be possible to develop an even shorter screening test using only the two reading comprehension passages from the S-TOFHLA. The reliability of the reading comprehension passages was excellent (Cronbach's alpha 0.97). The correlation between the reading comprehension passages and the REALM was 0.81, similar to the correlation between the complete S-TOFHLA and the REALM (0.80). By comparison, the reliability of the Numeracy items was only modest (0.68), and its correlation with the REALM (0.61) was lower. While deletion of the Numeracy items would remove from the test the elements that most closely mimic the reading tasks patients most often face in the health care setting, use of the reading comprehension passages alone would provide a short instrument valid for screening patients' literacy in a clinical setting. The S-TOFHLA is probably the shortest instrument possible that still provides a *complete* assessment of functional health literacy. However, the reading comprehension passages alone may prove useful as a screening instrument to identify patients with very limited reading ability. We are currently completing additional work to compare the complete S-TOFHLA with the reading comprehension passages alone for use as a short clinical screening assessment of patients' literacy.

4.2. Comparison of the S-TOFHLA and the REALM

There were significant differences between the S-TOFHLA and the REALM, particularly in the mid-range of the tests. Overall, the REALM appeared to both overestimate and underestimate patients' reading ability when compared to the S-TOFHLA (Fig. 1 and Table 4). Some patients are able to read individual words on the REALM and pronounce them correctly but do poorly when their actual reading comprehension is assessed with the S-TOFHLA. Conversely, some patients may have difficulty pronouncing words in isolation on the REALM but do better on the S-TOFHLA when they have context to assist them (as they have in actual health care situations).

Although there is no gold standard for measuring health literacy, the S-TOFHLA should be a more valid measure than the REALM. The S-TOFHLA measures patients' ability to read and comprehend text (their actual reading proficiency), while the REALM measures only the ability to pronounce words in isolation. Moreover, the TOFHLA (and by inference the S-TOFHLA) has been shown to be an independent predictor of patients' knowledge of chronic disease and self-management skills, health status, and use of health care services [18,22]. Less is known about the relationship of the REALM to patients' self-management skills, health, and use of health care services, although REALM scores have been shown to be associated with women's knowledge and attitudes about mammography [23]. Nevertheless, the REALM requires only 3 minutes to complete. Further studies are necessary to determine the relative advantages and disadvantages of the S-TOFHLA and the REALM. Perhaps the more important message is that two screening instruments are now available that may be used to identify patients who require special efforts to achieve educational goals.

4.3. Practice implications

Patients who have completed 8 or fewer years of school are highly likely to have inadequate functional health literacy. Conversely, patients with education beyond high school are highly likely to have adequate functional health literacy. However, for the large proportion of patients who completed 9–12 years of school, it is difficult to identify patients with inadequate literacy without formal testing. If such patients are entering formal patient education programs for chronic diseases (e.g. diabetes, asthma, or heart failure), it may be helpful to screen for inadequate literacy to identify individuals who are unlikely to comprehend even the simplest written patient education materials. These individuals are likely to need more direct teaching and follow-up

by health educators, nurses, and physicians. Without special efforts, this group will be less likely to take medications correctly, follow diet and exercise instructions, and understand plans for care of their medical conditions [18,22].

To help guide education programs, health educators should also consider screening the general patient population at their institution to determine the proportion of patients with inadequate functional health literacy. For example, in this study, the overwhelming majority of patients at Grady Memorial Hospital over 45 years old had inadequate functional health literacy. This would suggest that more direct teaching is needed to help chronically ill, older adults understand their diseases and treatment programs; relying predominantly on written materials is likely to be unsuccessful.

For those patients who require screening, the development of the S-TOFHLA now makes it possible to reliably identify individuals with inadequate functional health literacy in approximately 10 minutes. Although the S-TOFHLA tests patients' reading ability, health educators and health care providers should be aware that individuals with inadequate functional health literacy may also have difficulties understanding oral communication. Additional research is needed to evaluate the efficacy of alternative methods of education such as audio or videotapes and computer-assisted learning programs. Such research should assess patients' functional health literacy to determine whether educational programs and innovative tools are reaching all patients, regardless of reading ability.

Copies of S-TOFHLA may be obtained at a nominal charge from: Center for the Study of Adult Literacy, Georgia State University, University Plaza, Atlanta, GA 30303; Tel.: +1 404 6512405; fax: +1 404 6511415; e-mail: alcsvv@langate.gsu.edu

Appendix 1

Numeracy items and sample reading comprehension passage

NUMERACY ITEM 1 *(Label on prescription bottle)*

Take one tablet by mount every 6 hours as needed.

ORAL QUESTION: If you take your first tablet at 7:00 a.m., when should you take the next one?
CORRECT ANSWER: "1:00 p.m."

NUMERACY ITEM 2 *(Prompt card)*

Normal blood sugar is 60–150. Your blood sugar today is 160.

ORAL QUESTION: If this was your score, would your blood sugar be normal today?
CORRECT ANSWER: "No"

NUMERACY ITEM 3 *(Prompt card)*

CLINIC APPOINTMENT

CLINIC: Diabetic LOCATION: 3rd floor

DAY: Thurs. DATE: April 2nd HOUR: 10:20 a.m. / p.m.

Issued by:

YOU MUST BRING YOUR PLASTIC CARD WITH YOU

ORAL QUESTION: When is your next appointment?
CORRECT ANSWER: "April 2nd" or "Thursday, April 2nd"

NUMERACY ITEM 4 *(Label on prescription bottle)*

Take medication on empty stomach one hour before or two to three hours after a meal unless otherwise directed by your doctor.

ORAL QUESTION: If you eat lunch at 12:00 noon, and you want to take this medicine before lunch, what time should you take it?
CORRECT ANSWER: ''11:00'' or ''before 11:00''

Reading Comprehension Passage A (page 1)

Your doctor has sent you to have a	_____ a. stomach b. diabetes c. stitches d. germs	X-ray.
You must have an	_____stomach when you come for a. asthma b. empty c. incest d. anemia	_____. a. is b. am c. if d. it
The X-ray will	_____ from 1 to 3 a. take b. view c. talk d. look	_____ to do. a. beds b. brains c. hours d. diets

THE DAY BEFORE THE X-RAY

For supper have only a	_____ snack of fruit, a. little b. broth c. attack d. nausea	_____ and jelly, with coffee or tea. a. toes b. throat c. toast d. thigh

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