Readability assessment of American Shoulder and Elbow Surgeons patient brochures with suggestions for improvement

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Background: Many Americans have limited literacy skills, and the National Institutes of Health (NIH) suggests patient educational material be written below the 8th grade level. Many orthopedic organizations provide print material for patients, but whether these documents are written at an appropriate reading level is not clear. This study assessed the readability of patient education brochures provided by the American Shoulder and Elbow Surgeons (ASES).

Materials and Methods: In May 2017, 6 ASES patient education brochures were analyzed using readability software. The reading level was calculated for each brochure using 9 different tests. The mean reading level for each article was compared with the NIH-recommended 8th grade level using 2-tailed, 1-sample t tests assuming unequal variances.

Results: For each of the 9 tests, the mean reading level was higher than the NIH-recommended 8th grade (test, grade level): Automated Readability Index, 14.1 ($P < .05$); Coleman-Liau, 14.2 ($P < .05$); New Dale-Chall, 13.2 ($P < .05$); Flesch-Kincaid, 13.7 ($P < .05$); FORCAST, 11.8 ($P < .05$); Fry, 15.8 ($P < .05$); Gunning Fog, 16.5 ($P < .05$); Raygor Estimate, 15.4 ($P < .05$); and Simple Measure of Gobbledygook (SMOG), 15.1 ($P < .05$).

Conclusions: The ASES patient education brochures are written well above the NIH-recommended 8th grade reading level. These findings are similar to other investigations concerning orthopedic patient education material. Supplementary brochures and websites could be a useful source of information, particularly for patients who are deterred from asking questions in the office. Printed material designed for patient education should be edited to a more reasonable reading level. Further review of patient education materials is warranted.

Approximately one-third of the adult population in the United States has basic or less than basic health literacy.[37] Poor health literacy has been associated with negative outcomes and $50 to $73 billion per year of increased health care costs.[38] The reading skills of a patient are often overlooked when patient education materials are designed,[1] which should be written at an appropriate reading level. Recommendations vary,[3,22,23] but the National Institutes of Health (NIH) suggests a 6th to 8th grade reading level.[34,38] This is not intended to "dumb down" the material; rather, it is a part of the NIH mission to provide Americans with health information they can use. The NIH supports the Plain Language initiative, which has its origins in a federal directive.[23] In October 2010, the Plain Writing Act was signed into law. The law requires all federal publications,

forms, and public documents to be clear, concise, and well-organized.[33]

The readability of patient-oriented materials has been a common subject in recent orthopedic literature,[5,7,11,19,25] and most studies have found that very few online documents are written at an appropriate level.[2,6,31,32,35] Although print material may be accessed less frequently than online material, a Pew survey found that nearly 60% of people who initially learn about their diagnoses online eventually see a clinician.[8] The doctor's office is frequently supplied with brochures from industry or specialty groups. The goal of this study is to assess the readability of patient education brochures provided by the American Shoulder and Elbow Surgeons (ASES). The hypothesis was that the ASES patient education brochures would be written higher than the 8th grade reading level.

Materials and methods

In May 2017, the 6 available patient education brochures were ordered from the ASES. These brochures were:

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1. Arthritis and Total Shoulder Replacement
2. Arthroscopy of the Shoulder and Elbow
3. Rehabilitation of the Shoulder
4. Rotator Cuff Tendonitis and Tears
5. Tennis Elbow
6. The Unstable Shoulder

All brochures were written in English. The content of each was copied as plain text into an individual Microsoft Word document (Microsoft Corp., Redmond, WA, USA). In accordance with the readability software guidelines, figures, figure legends, copyright notices, disclaimers, acknowledgements, citations, and references in the brochures were excluded.

The Word documents were analyzed using Readability Studio Professional Edition 2015 (Oleander Software, Ltd., Vandalia, OH, USA). Within the program, 9 different readability scores were calculated for each article. These formulas were:

1. Flesch Kincaid Grade Level
2. Simple Measure of Gobbledygook Index (SMOG)
3. Coleman-Liau Index
4. Gunning Fog Index
5. New Dale-Chall Formula
6. Raygor Readability Estimate
7. Fry Readability
8. Automated Readability Index
9. FORCAST

Each of these tests has been used for analyzing patient education materials.[14,27,29,36] The tests are based on the sample text's syllables, words, and sentences (Table I), but each formula weights these components differently. Some formulas have additional components. The Dale-Chall formula contains a factor of "unfamiliar words," which Dale and Chall chose based on assessment of 4th grade Americans.[4] The Fry and Raygor reading levels are determined by plotting the calculated score to an accompanying readability graph. This graphing was performed automatically by the readability software. The Flesch-Kincaid Grade level,[20] SMOG,[18] Fog,[18] Fry,[10] and Dale-Chall[4] tests have been individually validated.

The more commonly used readability tests, the Flesch-Kincaid and Automated Readability Index, were originally developed for the United States Navy in 1975 for analyzing technical manuals; the Flesch-Kincaid is now the United States Military Standard.[16] The Fog Index was validated using McCall-Crabbs' Test Lessons in reading and was developed to predict the grade level of individuals who could correctly answer 90% of the passage's comprehension questions.[18] The SMOG index was also validated using Test Lessons in reading, except it was based on answering 100% of the questions correctly, so the grade levels predicted by SMOG are sometimes higher.[9]

Although there is no gold standard, a review by Friedman and Hoffman-Goetz[9] noted that many of these formulas correlate strongly with each other, and using more than one to increase validity is recommended.[1] Additional information regarding commonly used readability tests is presented in a thorough review of the topic by Badarudeen and Sabarwhal.[1]

Reading level was calculated for each article by averaging the 9 readability scores. The mean reading level for each article was compared with an 8th grade level using 2-tailed, 1-sample t tests assuming unequal variances. Normality of the sample distribution was tested with the Shapiro-Wilk test. All statistical tests were performed using R 3.4.0 software[28] (R Foundation for Statistical Computing, Vienna, Austria) with RStudio 1.0.153 software[30] (RStudio Inc., Boston, MA, USA). An α level of 0.05 was determined.

Recommended reading levels range from 1 to 5 grades below the intended audience.[3,22,23] Most Americans have completed 10 to 13 years of schooling,[17] so the 8th grade was chosen as a conservative measure in accordance with the NIH recommendations.[34]

Results

The results confirmed the hypothesis that the reading level of the brochures would be higher than the 8th grade. The readability scores of all 6 brochures were calculated with each of the 9 readability formulas, except for the "Rehabilitation of the Shoulder" brochure. The Fry and Raygor scores could not be calculated for this brochure because it contained too many words with high syllable and character counts.

The mean reading level for the 6 brochures was higher than the recommended 8th grade reading level: Arthritis and Total Shoulder Replacement, (grade level) 15.3 ($P < .05$); Arthroscopy of the Shoulder and Elbow, 13.4 ($P < .05$); Rehabilitation of the Shoulder, 14.6 ($P < .05$); Rotator Cuff Tendinitis and Tears, 14.6 ($P < .05$); Tennis Elbow, 13.2 ($P < .05$); and The Unstable Shoulder, 15.2 ($P < .05$; Fig. 1 and Table II).

For each of the 9 tests used, the mean reading level was higher than the recommended 8th grade: Automated Readability Index (grade level) 14.1 ($P < .05$); Coleman-Liau, 14.2 ($P < .05$); New Dale-Chall, 13.2 ($P < .05$); Flesch-Kincaid, 13.7 ($P < .05$); FORCAST, 11.8 ($P < .05$); Fry, 15.8 ($P < .05$); Gunning Fog, 16.5 ($P < .05$); Raygor Estimate, 15.4 ($P < .05$); and SMOG, 15.1 ($P < .05$; Table II).

Table I
Display of the 8 readability formulas used to calculate the reading level for each article

Assessment	Formula	Legend
Flesch-Kincaid Grade	$(0.39 \times B) + (11.8 \times W) - 15.59$	B = average number of syllables per word; W = average number of words per sentence
Simple Measure of Gobbledygook (SMOG)	$1.043 \times \sqrt{(P \times 30/S)} + 3.1291$	P = number of words with 3 or more syllables; S = number of sentences
Coleman-Liau	$(0.0588 \times L) - (0.296 \times T) - 15.8$	L = average number of letters per word; T = average number of sentences per 100 words
Gunning Fog Index	$0.4 \times (W/S + 100 \times P/W)$	S = average number of sentences; W = average number of words per sentence; P = average number of words with 3 or more syllables
New Dale-Chall	$0.0496 \times W/S + 0.1579 \times U/W + 3.6365$	W = average number of words; S = average number of sentences; U = unfamiliar words
Raygor	Average number of sentences and syllables per 100 words (graphed to corresponding grade level)	
Fry	Average number of sentences and long words per 100 words (graphed to corresponding grade level)	
Automated Readability Index	$4.71 \, (C/W) + 0.5 \, (W/S) - 21.43$	C = characters; W = words; S = sentences
FORCAST	$20 - SS/10$	SS = number of single syllable words in 150-word sample