Research Article

BIOMEDICAL Journal of Scientific & Technical Research

ISSN: 2574 -1241

DOI: 10.26717/BJSTR.2021.37.006053

Readability Assessment of Internet-Based Patient Education Materials on Anticoagulation Therapy

Kehinde Adebisi*, Adedolapo Ojo and Nelson Aluya

University of Mississippi Medical center, USA

***Corresponding author:** Kehinde Adebisi, University of Mississippi Medical center, USA

ARTICLE INFO

Received: July 17, 2021

Published: August 04, 2021

Citation: Kehinde Adebisi, Adedolapo Ojo, Nelson Aluya. Readability Assessment of Internet-Based Patient Education Materials on Anticoagulation Therapy. Biomed J Sci & Tech Res 37(5)-2021. BJSTR. MS.ID.006053.

ABSTRACT

Background: Since the advent of the Web and media, there has been a significant change in the practice of Medicine. The physician is no longer the sole custodian of medical knowledge. A substantial amount of consumer health-related information is available on live streaming, other Internet sources and social media. Nearly two-thirds of American adults (65%) use social networking sites, up from 7% when Pew Research Center began systematically tracking social media usage in 2005. Pew Research reports have documented in great detail how the rise of social media has affected such things as work, politics and political deliberation, communications patterns around the globe, as well as the way people get and share information about health [1]. Studies suggest that consumer comprehension may be compromised if content exceeds what an average American can easily understand. The average reading level in the United States is 8th grade. The National Institutes of Health and the US Department of Health and Human Services (USDHHS) recommend that patient education materials (PEM's) be written at or below the 6th grade level [2,3].

Objective: To determine the readability level of published materials likely to be encountered by a patient following a Google search of the phrase "blood thinners", a popular synonym of anticoagulant.

Study Design: Analysis of Internet-based PEMs on anticoagulation therapy.

Methods: PEMs from the first 12 websites encountered on a Google search of the phrase, "blood thinners," were downloaded and assessed for readability using 9 different indices: Flesch Reading Ease (FRE), Gunning Fog Index (GFI), Flesch-Kincaid Grade Level (FKGL), Coleman-Liau Index (CLI), SMOG Formula (SMOG), Automated Readability Index (ARI), Linsear Write Formula (LWF), Fry Readability Graph (FRG) and Raygor Estimate Graph (REG). www.readabilityformulas.com was used to compute these readability scores as well as an average grade level. Data were analyzed using the www.endmemo.com.

Results: The average reading levels of the 12 PEM's were between the 7th and 14th grade with the overall average calculated between the 10th and 11th grade. The mean readability and standard errors of mean are as follows: FRE 53.2 +/- 3.9, GFI 12.1 +/- 0.53, FKGL 10.2 +/- 0.67, CLI 10.8 +/- 0.49, SMOG 9.8 +/-0.51, ARI 10.3 +/- 0.63, LWF 11.4 +/- 0.74, FRG 10.8 +/- 0.57, REG 6.4 +/- 0.3 and average grade level10.5 +/- 0.57.

Conclusion: Our findings support that internet-based medical information on anticoagulation therapy intended for consumer use is written well above USDHHS recommended 6th-grade reading levels. Compliance with these recommendations may increase the likelihood of consumer comprehension.

Introduction

Anticoagulants (blood thinners) are the mainstay therapy for acute and long-term treatment and prevention of numerous inheritable and acquired thrombo-embolic disorders (antiphospholipid antibodies, Protein C deficiency, Chronic atrial fibrillation, Deep venous thrombosis, Stroke, etc.). A study done in 2007 by Agency for Healthcare Research and Quality (AHRQ) revealed that about 4.2 million Americans aged 18years or older had at least one outpatient anticoagulant purchase. The study further revealed that there were 27.9 million anticoagulant purchases and $905.2 million was spent for outpatient anticoagulants in 2007 [4]. Internet based patient education materials (PEM) are playing an increasingly prominent role in a patient's understanding of disease and the patient-physician relationship. Since the advent of the Web, the practice of medicine has shifted significantly. No longer is the physician sole gatekeeper of medical knowledge. Patients have more and more recent medical information at their fingertips. Internet proposes an easy-to-use, universal access to information and provides various possibilities to find the latest up-to-date, barrier free information that is independent of location and time. Interactive services like online self-help-groups, chats with experts and forums on special health topics can support active coping and social support in a virtual community by anonymous contact. 71.7 percent of households reported accessing the Internet in 2011, up from 18.0 percent in 1997 (the first year the Census Bureau asked about Internet use) and 54.7 percent in 2003 [5].

The term "health literacy," as described by the Joint Commission (formerly the Joint Commission on Accreditation of Health Care Organizations), refers to "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions."2 The impact of literacy on health is significant. Adults with low literacy skills have a poorer health status, 18 have average health costs that are 6 times higher, 19 are less likely to comply with medication regimens, and are less likely to understand their illnesses. Reading level is an important component of health literacy. The most recent large-scale national assessment of the average reading level among Americans was performed by the National Center for Education Statistics in 2003. It found that the typical American reads between a 7th and 8th grade level [5,6]. The United States Department of Health and Human Services (USDHHS) resolved that material is considered "easy to read" only if written below a 6th-grade level. Material between the 7th and 9th grade levels is viewed as "average difficulty," and material above the 9th-grade level is regarded as "difficult [7]. Readability is a measure of the grade level necessary for an individual to adequately comprehend a written document [8]. A number of objective scales have been used throughout literature to calculate the readability of documents; including the Flesch Reading Ease Score (FRES), Flesch-Kincaid Grade Level (FKGL), Simple Measure of Gobbledygook (SMOG), Gunning Frequency of Gobbledygook (Gunning FOG), Raygor Graph Grade Level, Coleman Liau Index, Automated Readability Index, and the Linsear Write Formula.

Materials and Methods

In July 2016, the key phrase, "blood thinners," was typed into the Google search engine, and all of the websites that appeared on the first page of results were opened. In all, there were 12 websites, each one having multiple articles/subsections, for a total of 69 different hyperlinks related to anticoagulant therapy. The 69 WebPages were then subjected to analysis. The 12 websites analyzed were as follows (in the order they appeared in the Google search): Xarelto.com, Eliquis customer website, Pradaxa.com, medlineplus.gov, WebMD, Agency for healthcare research and quality (AHRQ), Drugwatch, Info web of University of North Carolina, Healthline, Texas Heart institute, and Everyday health. All pages examined were written for patient education.

Inclusion Criteria:

a) Website written in English Language

b) Patient directed Exclusion Criteria:

c) Broken or dead links

d) Written for experts or clinician

The material from each of the 69 WebPages was copied and pasted into a separate Microsoft Word document. The documents were then scrutinized for any text that was not related to anticoagulation therapy. Examples include author information, sponsor information, disclaimers, and hyperlinks to other websites, copyright notices, references, citations, website information, and URL's. These types of text were then deleted from the document to prevent skewing of the readability statistics. Each Microsoft Word document was then subjected to readability analysis. Each page was copied and pasted into an online readability assessment tool www.readabilityformulas.com, to obtain 9 different readability scores Flesch Reading Ease (FRE), Gunning Fog Index (GFI), Flesch-Kincaid Grade Level (FKGL), Coleman-Liau Index (CLI), SMOG Formula (SMOG), Automated Readability Index (ARI), Linsear Write Formula (LWF), Fry Readability Graph (FRG) and Raygor Estimate Graph (REG), as well as the average grade level across all 9 calculators. Each of these 9 indices assesses the documents using different variables and formulas to generate an estimated reading level. These variables and formulas are described in Table 1.

Table 1: Description of readability variables and formulas.

Scale	Description	Formula
Flesch Reading Ease FRE	Average number of syllables (B), average number of words per sentence (W), average number of sentences (S)	206.835 – (84.6 X (B/W))-(1.015 X W/S)
Coleman-Liau Index CLI	Average number of letters per 100 words (L) and average number of sentences per 100 words (S)	(0.0588 X L) -(0.296X S) -15.8
Flesch-Kincaid Grade Level	Average number of syllables per word (SY) and average number of words per sentence (W)	FKGL= (0.39 X W) + (11.8 X SY)- 15.59
Fry Graph point on the chart (3 samples recommended for best results)	Average number of sentences and syllables per 100 words	1) Extract a 100-word passage from the selection 2) Count the number of sentences in each passage (count a half sentence as 0.5) 3) Count the number of syllables in each passage 4) Find the
Gunning Fog Index	Number of sentences (S), number of words (W), number of words with ≥3 syllables (C)	GFI =0.4 × (W/S + (C/W) ×100)
Raygor Readability Estimate	Average number of sentences and long (6 characters) words per 100 words	1) Select a 100-word passage from the selection 2) Count the number of sentences, estimated to the nearest tenth 3) Count the number of words that are 6 letters 4) Find the point on the chart (3 samples recommended for best results)
SMOG Readability Formula	Average number of words with 3 syllables (C) and average number of sentences (S)	SMOG =1.043 ×∫ (C × (30/S)+ 3.1291)

The FRE, FKGL, GFI, CLI, SMOG, ARI, and LWF provide numerical reading scores via mathematical formulas, while the FRG and REG provide graphical representation of the readability.

a) The FRE is a numerical score between 0 and 100, with a higher number indicating a more readable document. It is influenced by average sentence length and average syllables per word [7]. Table 2 breaks down this scale to correlate the numerical values with a level of difficulty and associated grade level [8,9].

b) The FKGL assesses the same variables as the FRE but generates a grade level rather than a numerical score [10].

c) The GFI calculates a grade level based on average sentence length and percentage of words with more than 3 syllables, i.e. complex words.10 (4) The CLI generates a grade level based on the average numbers of sentences and characters per 100 words [11].

d) The SMOG Formula uses the numbers of sentences and complex words to generate a grade level [12].

e) The ARI calculates a grade level using the average word length and average sentence length [13].

f) The LWF uses the numbers of complex words, easy words (2 syllables or less), and sentences to generate a grade level [14].

g) The FRG generates a graph using the average numbers of syllables and sentences per 100 words, where the two lines intersect indicates the reading level of the document [15].

h) The REG uses the average numbers of sentences and long words (6 or more characters) per 100 words to generate a grade level via an intersecting point on a graph, similarly to the FRG [16]. The REG tends to estimate the grade level of a document several points below the FRG and all of the other readability indices. For this reason, medical researchers do not use it as frequently [17] of these 9 tools, the FRE, SMOG, GFI, and FRG are the most widely used readability calculators by medical experts, the other scales being referenced less often [9,17]. We felt that a composite average of multiple scales would be a more accurate approach to determining the true grade levels of these documents than any one or two scales used alone.

The readability data were then analyzed using the endmemo website (www.endmemo.com). Their basic statistical calculator was used to generate means and standard errors of the mean for all readability indices. First, since the 69 WebPages all had their own readability scores, we sought to generate composite scores for each of the 12 parent websites. For example, Xarelto.com had 6 individual WebPages that were each analyzed separately for readability. We used the stats calculator to generate averages for each readability index, across these 6 pages, to provide composite values for Xarelto.com as a whole. After the mean scores were calculated for each of the 12 parent websites, we used the stats calculator to generate an overall mean, with standard error, for each of the readability indices. An overall grade level, factoring in all websites and scales, was our final calculation.

Table 2: Understanding Fleisch reading ease.

Score	School Level	Notes
90.0–100.0	5th grade	Very easy to read. Easily understood by an average 11-year-old student.
80.0–90.0	6th grade	Easy to read. Conversational English for consumers.
70.0–80.0	7th grade	Fairly easy to read.
60.0–70.0	8th & 9th grade	Plain English. Easily understood by 13- to 15-year-old students.
50.0–60.0	10th to 12th grade	Fairly difficult to read.
30.0–50.0	college	Difficult to read.
0.0–30.0	college graduate	Very difficult to read. Best understood by university graduates.

Results

A total of 69 WebPages from 12 parent websites were analyzed for their level of readability using 9 different readability indices. Table 3 (A-L) provides a summary of the results broken down by website. The FRE scores has wide variability between websites, as shown by a wide range of 22.3 – 65.6, with a mean score of 53.2 +/- 3.9 standard errors of the mean; this score corresponds with a "fairly difficult" readability (10th -12th grade) Table 4. The FKGL scores displayed a tighter range, with a mean score of 10.3 +/- 0.54. The FRG graphs were somewhat similar between websites with a mean grade level of 10.8 +/- 0.57. The REG graphs were also similar, as demonstrated by the clustering, with a mean readability index of 6.4 +/- 0.3. The GFI, CLI, SMOG, ARI, and LWF means were calculated as 12.1 +/- 0.53, 10.8 +/- 0.49, 9.8 +/- 0.51, 10.3 +/- 0.63, and 11.4 +/- 0.74 respectively. The average reading levels for each website showed that they were written between a range of 7th and 14th grade, with the mean calculated at 10.5 +/- 0.57. This is correlated with a "fairly difficult" readability (Table 2). Xarelto.com is written at the highest level of all 12 websites with a grade level of 14 and a FRE score of 22.3, indicating that it is "very difficult to read, best understood by University graduates." Table 5 Agency for Healthcare Research and Quality's (AHRQ) patients guide and safety on blood thinner pills is the most easily read site out of the 12, with a grade level of 7 and a FRE score of 72; this indicates that it is of "Fairly easy to read" Table 6.

Table 3: WEB 1-Xarelto.com.

Readability Assessment Tests	Page1	Page2	Page3	Page4	Page5	Page6	Mean
GFI	19	8	15.1	17	11.3	18.9	14.9
FKGL	18.4	10.1	12.7	13.6	13.2	18.2	14.4
CLI	17	10	11	14	16	20	14.7
SMOG	15.3	9.6	11.6	13.1	10.7	16.3	12.8
ARI	18	6.3	10	11.9	12.5	19.7	13.1
LWF	18.4	7.3	12.6	13.3	9.1	18.5	13.2
FRG	17	9	12	12	12	20	13.7
REG	10	4	7	7	7.5	11	7.8
FRE	3.5	42.9	34.6	26.3	24	2.2	22.3
AVERAGE	17	9	12	13	12	19	13.7

Table 4: WEB2- Eliquis.bmscustomerconnect.

Readability Assessment Tests	Page 1	Page2	Page 3	Page 4	Page 5	Mean
FRE	49	57.2	45.2	53.5	55.4	52.1
GFI	13.7	12.6	8.8	12.2	10.7	11.6
FKGL	11.7	10.4	9.2	10.9	9.7	10.4
CLI	11	9	9	10	11	10
SMOG	11.1	10.2	8.9	10.4	9.7	10.1
ARI	12.1	10.1	4.7	11.2	10.1	9.6
LWF	14.2	13.4	5.9	13.5	11.1	11.6
FRG	13	12	8	12	11	9.2
REG	7	8	4	6	5	5.8
Readability consensus	12	10	8	11	10	10.2

Table 5: WEB 3-www.pradaxa.com.

Readability Assessment Tests	Page 1	Page 2	Page 3	Page 4	Mean
FRE	59.4	44.3	63	56.1	55.7
GFI	12.5	16.9	9.2	12.7	12.82
FKGL	10.3	14.6	8.1	10.6	10.9
CLI	9	10	10	9	9.5
SMOG	9.5	12.4	8.4	10.1	10.1
ARI	10.4	16.1	8.5	10.7	11.43
LWF	13.4	19.7	8.4	13.3	13.7
FRG	8	13	9	12.5	10.63
REG	6	8	5	7	6.5
Readability consensus	10	15	9	11	11.3

Table 6: WEB 4- medlineplus.gov.

Readability Assessment Tests	Page1	Page2	Page3	Page4	Page5	Page 6	Page 7	Page8	Mean
FRE	54.4	50.3	85.3	66.8	67.5	41.7	62.3	59.2	60.94
GFI	14.7	13.6	7.1	11.3	9.7	12.4	9.7	10.9	11.2
FKGL	11.4	11.9	4.4	8.3	7.3	13.4	8.1	9.5	9.3
CLI	11	11	6	9	10	12	10	11	10

Discussion

Patients access healthcare information outside the healthcare environment in a variety of ways. Books, pamphlets, and other reading materials are common information resources. Family and friends also are a longstanding source of information, support, and advice. Experiential learning comes from watching others and by searching the internet, viewing television, video, and movies. Access to digital information available on the Internet has introduced a vast world of new possibilities as the use of computer-based learning interventions incorporates all of this information and learning approaches in a multimedia learning environment [18]. The ease with which a patient can search the Internet has made it one of the most important sources by which they acquire health information. People are increasingly turning to search engines and popular medical sites to answer all of their medical questions. With the Internet's growing importance to patients, it is the responsibility of health care professionals to ensure that they are receiving high-quality information at a reading level that the average person could easily understand. The National Institutes of Health and the US Department of Health and Human Services (USDHHS) clearly state that all health information materials should be written below the 6th grade level to adequately ensure that a majority of the American population can understand it [19,20].

The phrase "Blood thinners" was searched on Google, subsequent analysis of the top 12 resulting websites showed that they are all written at levels that exceed the recommendations. The FRE, FKGL, FRG, GFI, CLI, SMOG, ARI, and LWF scales demonstrated that these sites were authored at difficulty levels above 8th grade, frequently reaching readabilities of 10th grade and higher. The REG calculations showed that most of the sites fell around the 6th - 7th grade, but this graph has been shown to underestimate readability several levels below the other scales [21]. Because the REG uses word length and the number of sentences to compute its results rather than syllable number and sentence length (which are better predictors of readability), it tends to lead to falsely low readability results [22]. Thus, we do not believe the REG results to be as accurate as the other scales that we used. Xarelto.com is written at the highest level of all 12 websites with a grade level of 14 and a FRE score of 22.3, indicating that it is "very difficult to read, best understood by University graduates." Tables 7-15. Agency for Healthcare Research and Quality's (AHRQ) patients guide and safety on blood thinner pills is the most easily read site out of the 12, with a grade level of 7 and a FRE score of 72; this indicates that it is of "Fairly easy to read." Table 2 Although this meets the reading level of the average American, it is still above the USDHHS recommendation for PEM readability.

Table 7: LWEB 5- WebMD.

Readability Assessment Tests	Page 1	Page 2	Page 3	Page 4	Page 5	Page 6	Mean
FRE	67.8	81.2	50.5	69.9	65.6	51	64.3
GFI	8.9	8.2	14.8	8.7	10.8	10.9	10.4
FKGL	7.6	5.1	10.1	7	8.3	9.4	7.9
CLI	8	7	10	9	8	13	9.2
SMOG	8	6.2	10.9	6.8	7.9	9.6	8.2
ARI	6.9	4.4	9.1	6.9	7.9	9.9	7.5
LWF	8.4	6.4	11.4	7.4	9.3	8.3	8.5
FRG	8	6	13	8	9	10	9
REG	7	5	7	4.5	8	7	6.4
Readability consensus	8	6	10	7	8	10	8.2

Table 8: WEB 7- AHRQ.

Readability Assessment Tests	PAGE 1	PAGE 2	PAGE 3	PAGE 4	PAGE 5	PAGE 6	PAGE 7	PAGE 8	PAGE 9	PAGE 10	Mean
FRE	63.3	68.5	82.2	72	51.9	66.4	73.1	81.6	79.4	81.1	72
GFI	9.9	9.5	8.8	9.5	11.4	10.6	7.7	6.9	8.1	6.9	8.9
FKGL	8.4	7.5	5.2	6.2	9.9	8.3	5.3	4.7	5.1	5.2	6.6
CLI	10	10	6	10	11	10	9	8	8	8	9
SMOG	7.6	7	6.3	7.2	9	7.4	6.2	5	6	6.2	6.8
ARI	8.7	8.2	4.3	6.7	9.7	9.6	4.2	4.7	4.8	5.8	6.7
LWF	8.7	8.1	7.1	6.5	9.2	9.3	4.5	5.4	5.9	6.5	7.1
FRG	9	8	6	8.5	13	9	6	6	6	6	7.8
REG	5	5	3	3	5	6.5	3	5	4	4	4.4
Readability consensus	9	8	6	7	10	9	6	6	6	6	7.3

Table 9: WEB 8- Drugwatch.com.

Readability Assessment Tests	Page 1	Page 2	Page3	Page 4	Mean
FRE	44.4	47.2	49.5	46.8	47
GFI	13.4	13.4	12.7	14.4	13.5
FKGL	11.9	11.4	11.2	11.9	11.6
CLI	13	11	12	12	12
SMOG	11	10.4	10.1	11.2	10.7
ARI	12.8	11.2	11.9	12.7	12.2
LWF	13.3	12.7	12.8	14.2	13.3
FRG	14	13	13	13	13.3
REG	8	6	8	7	7.3
Readability consensus	12	11	12	12	11.8

Table 10: WEB 9-patientblog.clotconnect.org.

Readability Assessment Tests	Page 1	Page 2	Page 3	Page 4	Page 5	Page6	Mean
FRE	44.1	50.1	38.5	45.5	47.2	44.1	44.9
GFI	11.9	10.6	16	14.2	14.2	11.9	13.1
FKGL	10.9	10.3	13.9	12.6	10.9	10.9	11.6
CLI	11	9	12	11	11	11	10.8
SMOG	10.5	10.2	12.7	11.9	10.8	10.5	11.1
ARI	9	7.9	14.4	12.6	10.4	9	10.6

LWF	10.9	11.1	17	15.6	12	10.9	12.9
FRG	13	10	14	13	11	11	12
REG	8	6	8	8	6.5	6.5	7.2
Readability consensus	11	10	14	13	11	11	11.7

Table 11: WEB 10- Healthline.

Readability Assessment Tests	Page 1	Page 2	Page 3	Page4	Mean
FRE	48.5	48.9	44	57.7	49.7
GFI	13	12.7	14.1	11.5	12.8
FKGL	10.8	10.7	12.2	9	10.7
CLI	13	12	13	11	12.3
SMOG	10	9.9	11.1	9	10
ARI	11.9	11	13.4	9.1	11.6
LWF	11.7	11.5	14	9.1	11.6
FRG	12	11	12	9	11
REG	6	6	7	5	6
Readability consensus	12	11	13	9	11.3

Table 12: WEB 11- TexasHealthinstitute.

Readability Assessment Tests	Page 1	Page 2	Page 3	Page 4	Mean
FRE	60.1	45.6	71.8	58.2	58.9
GFI	10	13	9.3	14.3	11.7
FKGL	8	11.8	6.6	10.6	9.3
CLI	11	14	9	11	11.3
SMOG	8	11.1	7.1	10.7	9.2
ARI	8.1	14	6.6	12.3	10.3
LWF	7.2	13.5	7.2	14.4	10.6
FRG	13	14	6	12	11.3
REG	5	8	7	8	7
Readability consensus	8	13	7	12	10

Table 13: WEB 12- everydayhealth.

Readability Assessment Tests	Page 1	Page 2	Page 3	Page 4	Page 5	Page 6	Mean
FRE	47	41.3	34	37.8	52.6	56.2	44.8
GFI	13.9	13.8	14.6	14.3	13.9	13.2	14
FKGL	11.9	13.2	14.3	13.3	11.2	10.8	12.5
CLI	12	12	12	12	10	9	11.2
SMOG	11.2	12	13.4	12.6	10.1	10.4	11.6
ARI	12.7	13.6	14.3	13	11.4	11	12.7
LWF	14.1	15.7	17.1	15.5	13.6	14	15
FRG	14	12	12	14	12	11	12.5
REG	7.5	7	7	7.5	7	6.5	7.1
Readability consensus	12	13	14	13	11	11	12.3

Table 14: Overall Table.

Readability Assessment Tests	Web 1	Web 2	Web 3	Web 4	Web 5	Web 6	Web 7	Web 8	Web 9	Web 10	Web 11	Web 12	ME AN	SE
FRE	22.3	52.1	55.7	60.94	64.3	65.6	72	47	44.9	49.7	58.9	44.8	53.2	3.9
GFI	14.9	11.6	12.8	11.2	10.4	10.2	8.9	13.5	13.1	12.8	11.7	14	12.1	0.53

FKGL	14.4	10.4	10.9	9.3	7.9	7.6	6.6	11.6	11.6	10.7	9.3	12.5	10.2	0.67
CLI	14.7	10	9.5	10	9.2	9.7	9	12	10.8	12.3	11.3	11.2	10.8	0.49
SMOG	12.8	10.1	10.1	9	8.2	7.9	6.8	10.7	11.1	10	9.2	11.6	9.8	0.51
ARI	13.1	9.6	11.4	10.1	7.5	7.7	6.7	12.2	10.6	11.6	10.3	12.7	10.3	0.63
LWF	13.2	11.6	13.7	11.3	8.5	8	7.1	13.3	12.9	11.6	10.6	15	11.4	0.74
FRG	13.7	9.2	10.6	10.2	9	8.5	7.8	13.3	12	11	11.3	12.5	10.8	0.57
REG	7.8	5.8	6.5	6.4	6.4	4.9	4.4	7.3	7.2	6	7	7.1	6.4	0.3
Readability consensus	13.7	10.2	11.3	9.8	8.2	8.2	7.3	11.8	11	11.3	10	12.3	10.5	0.57

The readability level of patient information material contrasts with the observed patients' abilities to read. One third to one half of English-speaking patients have difficulty reading material at the 10th-grade level.24 25 Another compounding problem is that a patient's educational level does not automatically guarantee proficiency at that same level. Patients observed reading abilities are usually 3 to 5 grade levels below what they report as grade completed [23]. This study is limited in certain ways, which should be considered during further research. While we assume that patients use the Google search engine as a tool to research anticoagulation therapy, we do not have any conclusive evidence that patients use this particular method more than other search engines or search methods. While the PEM's that we studied were written above the recommended grade level, we did not consider whether patients are still able to gain valuable information from these PEMs and to what degree they are able to do so. We did not consider whether patients are self-selecting in regard to accessing internet-based PEMs; patients who access these PEMs in the first place might be more likely to read at a sufficient grade level to understand the content. Additionally, charts, data tables, and other non-text-based information, which were not analyzed via the readability formulas, might provide valuable information to patients.

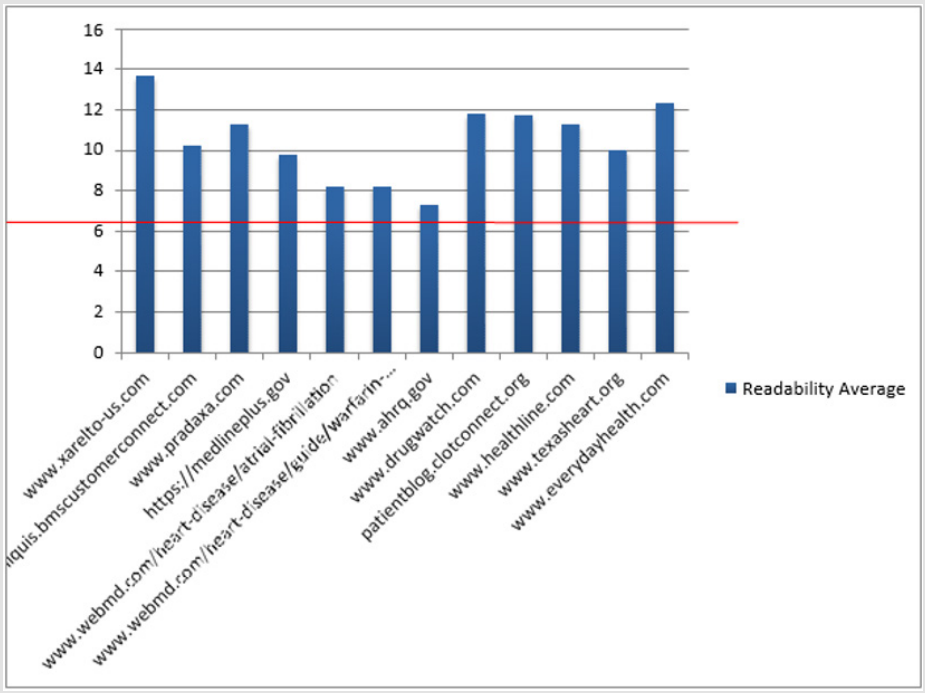

Figure 1: Y Axis- Grade level, X-axis-Websites Red line indicate the recommended readability level.

Patients taking anticoagulants who are at risk for bleeding and thrombosis need to learn and understand their condition. As increasing numbers of elderly patients with atrial fibrillation receive warfarin and other NOAC drugs, it is imperative to device an effective communication. Patient information should be written at an appropriate reading level, and its readability could be determined by using the various readability formulas. The National Work Group on Literacy and Health also recommends that material be written at or below the 6th-grade level, [24-30] because material written at higher levels is less likely to be read or understood. Developing patient information at a low readability level is necessary but not sufficient to improve comprehension. Our study suggests that health information sites on anticoagulation therapy need to be rewritten at more understandable levels. There are many ways that these sites can be altered to bring their readability scores down (Figure 1 and Figure 2). First of all, many of the writings used a large

number of medical terms; using smaller, less scientific words has the potential to drop many of the readability scores substantially. Limiting sentence length and reducing the complexity of sentence structure can also reduce scores and make the document far more easily understood. Other methods of communication, and written information that uses figures, pictograms, large font, and other characteristics, may also improve comprehension [31].

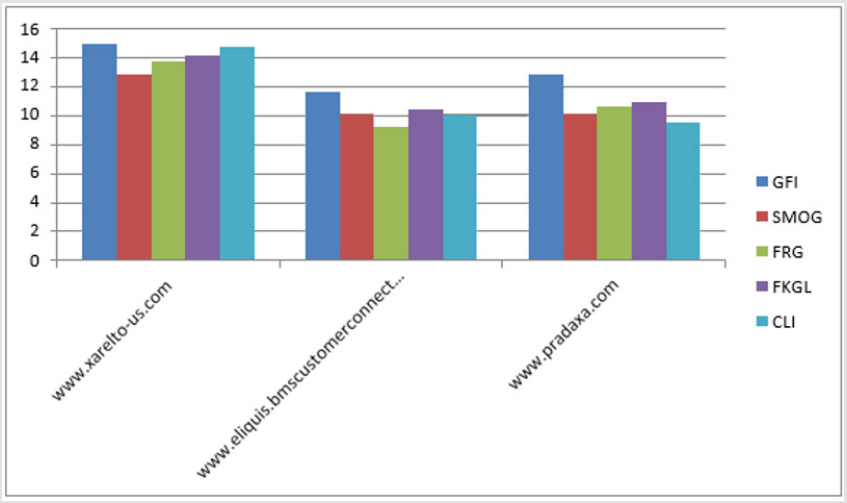

Figure 2: Comparing websites on the most popular direct thrombin inhibitors Y axis- Grade level X axis- Website comparison- Xarelto/eliquis/Pradaxa.

Conclusion

The Internet-based patient education materials on anticoagulation therapy are written at levels far above the recommendation of 6th grade. Due to a wide-spread pool of information, which can be personalized, Internet can enhance health literacy, health related knowledge and support people to become responsible for their own health. Hence, much attention needs to be paid to readability of these health education materials. Current Internet-based PEMs on anticoagulation therapy should be revised to make them more easily understood by the average American.

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ISSN: 2574-1241

DOI: 10.26717/BJSTR.2021.37.006053

Kehinde Adebisi. Biomed J Sci & Tech Res