Nuclear Medicine and Resources for Patients: How Complex are Online Patient Educational Materials?

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Word Count

RUNNING TITLE: Complexity of Nuclear Medicine Resources
ABSTRACT

The Internet is a major source of healthcare information for patients. The American Medical Association and National Institutes of Health recommend that consumer healthcare websites be written between a 3rd and 7th grade level. The purpose of this study is to evaluate the level of readability of patient education websites pertaining to nuclear medicine.

Methods: Ten search terms were Googled and the top 10 links for each term were collected and analyzed for their level of readability using 10 well-established readability scales.

Results: Collectively the 99 articles were written at an 11.8 grade level (standard deviation of 3.4). Only 5 of the 99 articles were written at the NIH and AMA recommended 3rd to 7th grade.

Conclusion: There is a clear discordance between the readability level of nuclear medicine related imaging terms with the NIH and AMA guidelines. This disconnect may negatively impact patient understanding contributing to poor health outcomes.

KEY WORDS: NUCLEAR MEDICINE, READABILITY, HEALTH LITERACY, PATIENT EDUCATION
INTRODUCTION

Today, the internet serves as an enormous source of medical information, especially for patients. It contains valuable resources, is easily accessible from almost anywhere, and helps patients make decisions, for better or worse, pertaining to their health. In fact, the number of individuals utilizing the web to access health information rose from 54 million in 1998 to over 117 million in 2005 (1). Over 80% of adults research health issues on the internet, yet more than half fail to communicate this newfound information to their physician (2,3). Thus placing a great deal of responsibility on the readability of these websites. Readability describes how easily a consumer can comprehend a written text. It takes into account content, style, format, and organization of the text. According to a study conducted by the National Assessment of Adult Literacy, 36% of Americans have basic or below basic health literacy, the ability to understand simple health information to make appropriate healthcare decisions, while another 5% were not competent enough to participate in the survey (4,5). That suggests over 90 million Americans struggle understanding the content of the websites they search and use to obtain their healthcare information.

The National Institutes of Health (NIH) and the American Medical Association (AMA) recommend patient education resources be written at a 3rd to 7th grade level (6,7). However, recent studies have shown that may not be the case. It appears that many medically relevant web sources overestimate the reading level of their user. Hansberry et al. reviewed the readability of patient education resources from RadiologyInfo.Org, and found that the articles were written between a 10th and 14th grade level (8). Eloy et al. assessed the readability of major otolaryngology association websites, and discovered they greatly exceed the AMA
recommended reading level (9). One area of medicine where readability is particularly important is nuclear medicine.

Given the complexity of nuclear medicine and the general public’s likely interest in learning about it, we evaluate the level of readability of patient education websites, written for the lay public, pertaining to nuclear medicine using a number of standard assessment scales. It is vital for a patient to understand any procedure they may undergo to ensure its success and prognostic value.

MATERIALS AND METHODS

In November 2016, a google search was performed using ten search terms and the top 10 links for each term were collected and individually analyzed for their level of readability using 10 well-established quantitative readability scales. The search terms included: nuclear imaging, nuclear medicine, PET scan, cardiac stress test, thyroid scan, VQ scan, bone scan, gamma ray, dexta scan, and radiotracers. Websites not written exclusively for patients were excluded from the analysis. One of the articles written on radiotracers contained too few words to be analyzed with the 10 readability scales and was excluded from the analysis. The quantitative readability scales were the following: Coleman-Liau Index, Flesch-Kincaid Grade Level, Flesch Reading Ease, FORCAST Formula, Fry Graph, Gunning Fog Index, New Dale-Chall, New Fog Count, Raygor Readability Estimate, and Simple Measure of Gobbledygook.

The Coleman-Liau Index measures how understandable a text is using characters (10). Both the Flesch-Kincaid Grade Level and Flesch Reading Ease gauge how challenging a text is but emphasize different factors (11,12). The Flesch-Kincaid Grade Level places greater weight on sentence length over word length while the Flesch Reading Ease does not. The Flesch Reading
Ease creates a score between 0-100 where the lower the score, the more difficult the passage is. The FORCAST Formula analyzes only vocabulary making it helpful for texts without proper structure (13). The Fry Graph calculates the grade reading level by taking into account the average number of sentences and syllables and displays it on a graph (14). The Gunning Fog Index estimates the education level a person needs to understand a passage on first reading (15). The New Dale-Chall scale calculates how difficult it is for readers to comprehend a test using a list of words that the majority of Americans can understand (16). The New Fog Count is adapted from the Gunning Fog Index and takes into account sentence length and words containing three or more syllables to calculate grade level (12). The Raygor Readability Estimate evaluates the average number of sentences and letters per hundred words and plots them graphically to estimate grade level (17). Lastly, the Simple Measure of Gobbledygook determines the number of years of education required to understand a passage (18).

RESULTS

A total of 99 articles were analyzed. The Coleman-Liau Index found the level of readability of the 99 articles equivalent to a grade level of 11.4 (standard deviation (SD) 2.7). The Flesch-Kincaid Grade Level reported the average readability of the articles at an 11.6 (SD 3.6) grade level. The Flesch Reading Ease reported the comfort with which a patient can understand these materials related to nuclear medicine with a mean score of 45.9 (SD 18.5) out of 100 for all 99 articles evaluated. The FORCAST Formula and New Dale-Chall scale determined the grade level required to understand the articles as 10.8 (SD 1.1) and 11.5 (SD 3.2), respectively. Similarly, both the Fry Graph (Figure 1) and Raygor Readability Estimate (Figure 2) found an average grade level too high for the average American, with average levels of
readability at the 12.9 grade level (SD 3.9) and 11.6 (SD 4.1), respectively. The Gunning Fog Index found the readability of the 99 articles to be at grade level of 13.2 (SD 3.3), while the Simple Measure of Gobbledygook reported a grade level of 13.6 (SD 2.8). The New Fog Count discovered the average readability to be written at a 9.9 (SD 3.2) grade level, which appears to be the lowest grade level but still much high than that recommended by the NIH and AMA. Collectively the 99 articles were written at an 11.8 grade level (SD 3.4). Only 5 of the 99 articles were written at the NIH and AMA recommended 3rd to 7th grade. Additionally, 47% of the material required at least a high school education (greater than 12th grade), while 11% needed at least a college education (greater than 16th grade) to fully understand.

DISCUSSION

The power of the internet as a primary source of medical information is stronger now more than ever as patients use it to build their medical knowledge and influence their healthcare decisions. Over 80% of all adults use web sources to look up health information with the possibility of accessing over a seemingly endless number of medically related texts and web pages (2). Yet despite this shift in primary medical resources, there appears to be a disconnection between the readability of the average American and each medical website. In fact, numerous studies evaluating the reading level of patient education resources among a variety of specialties including interventional radiology and neuroradiology have found them to be written way above the average American’s literacy capacity (19,20).

In regards to nuclear medicine, the internet can serve a vital role in helping patients further understand the field and clarify any misconceptions. However, the results of this study show that there is a clear discrepancy between the reading levels at which nuclear medicine
resources are written and those it is meant to inform. Implications of this chasm range from patients deterring from nuclear procedures that may prove vital in their healthcare decisions to developing complications from non-compliance. Therefore, it seems efficacious to reevaluate how nuclear medicine resources are written given the data presented in this study and the consequences. It can be added that if such resources are easier to understand, patients may seek nuclear medicine testing more often.

The limitations of this study include inherent issues in each readability scale. The scales do not take into consideration the content of the word. For example, words such as “dexamethasone” and “gamma” are short in length but the average patient is unlikely to fully understand what they mean. Similarly, longer polysyllabic words like “appointment” are reported as more complex but likely understood by a wider audience. Additionally, these readability scales do not factor in word order which affects patient understanding. We also did not evaluate videos, images, or other non-textual information that can contribute to how information is interpreted. Another limitation of this study concerns the homogeneity of internet use by patients with different levels of health literacy. It is possible that less literate people are less likely to use the internet. Therefore, future research may include investing in other avenues to spread comprehensible information to all types of patients regardless of their literacy levels. Additionally, it may be beneficial to evaluate each individual search term to see if some terms have a lower grade reading level than others i.e. bone scan may be deemed more readable than PET scan. Altogether, this may help alleviate some of the limitations of the study.

**CONCLUSION**
The internet is an omnipresent source of medical information, especially pertaining to nuclear medicine. The results of this study show that websites intended to educate and inform patients about nuclear medicine are written at a reading level well above that of the average American. This may stimulate a reassessment of how nuclear medicine material is expressed, perhaps altered, to include simpler sentences with smaller words to reach a broader population of patients. This can greatly aid both patients and physicians.
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FIGURES

Figure 1: Fry Graph with circles correlating with individual articles and their respective level of readability.
Figure 2: Raygor Reading Estimate with circles correlating with individual articles and their respective level of readability.