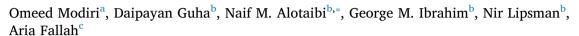Contents lists available at ScienceDirect

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Readability and quality of wikipedia pages on neurosurgical topics

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ABSTRACT

Objectives: Wikipedia is the largest online encyclopedia with over 40 million articles, and generating 500 million visits per month. The aim of this study is to assess the readability and quality of Wikipedia pages on neurosurgical related topics.

Patients and Methods: We selected the neurosurgical related Wikipedia pages based on the series of online patient information articles that are published by the American Association of Neurological Surgeons (AANS). We assessed readability of Wikipedia pages using five different readability scales (Flesch Reading Ease, Flesch Kincaid Grade Level, Gunning Fog Index, SMOG) Grade level, and Coleman-Liau Index). We used the Center for Disease Control (CDC) Clear Communication Index as well as the DISCERN Instrument to evaluate the quality of each Wikipedia article.

Results: We identified a total of fifty-five Wikipedia articles that corresponded with patient information articles published by the AANS. This constitutes 77.46% of the AANS topics. The mean Flesch Kincaid reading ease score for all of the Wikipedia articles we analyzed is 31.10, which indicates that a college-level education is necessary to understand them. In comparison to the readability analysis for the AANS articles, the Wikipedia articles were more difficult to read across every scale. None of the Wikipedia articles meet the CDC criterion for clear communications.

Conclusion: Our analyses demonstrated that Wikipedia articles related to neurosurgical topics are associated with higher grade levels for reading and also below the expected levels of clear communications for patients. Collaborative efforts from the neurosurgical community are needed to enhance the readability and quality of Wikipedia pages related to neurosurgery.

1. Introduction

The popularity and growth of Web 2.0 tools have led to a significant change in the way people access information and interact with the world. Web 2.0 tools refer to online instruments that a website can implement to allow an individual to interact with a webpage and generate content [1]. The development of these tools has given rise to new forms of online media, including blogs, social networks, social media, and wikis, which is largely due to this unique ability for people to engage with online material. Wikipedia, a website developed through the use of Web 2.0 tools, is the largest online, non-peer reviewed encyclopedia with over 40 million articles in more than 250 languages, generating 500 million visits per month from different users [2].

Websites that allow for user generated content, such as Wikipedia,

have become an increasingly utilized resource. Due to its popularity, Wikipedia is a powerful tool that many will often reference, including patients looking to learn more about their health or medical condition [3]. Thus, Wikipedia can be used to increase health awareness and to help individuals access information regarding medically related topics, including neurosurgery. As such, it is important to analyze the articles on Wikipedia, and to improve them as an online resource for the general public. Similar readability analyses of Wikipedia articles have already been conducted on other medically related content, including autoimmune disorders [4], Parkinson's disease [5], and cardiovascular conditions [6]. The American Association of Neurological Surgeons (AANS) have published their own series of public educational medical articles regarding neurosurgical related conditions, many of which have a corresponding or related Wikipedia article.

The goal of this study is to assess the readability and quality of

Wikipedia pages on neurosurgical related topics, and in addition, to compare these results to online patient information articles published by the AANS.

2. Material and methods

2.1. Articles selection

We selected the neurosurgical related Wikipedia pages based on the series of online patient information articles that are published by the AANS. In order to accurately compare the readability of Wikipedia to that of the AANS, we only selected articles on Wikipedia in which the topic was identical to a corresponding AANS article. Each of the AANS articles was categorized under one of seven categories: Cerebrovascular, Spine and Peripheral Nerves, Neurotrauma and Critical Care, Pain, Pediatric, Stereotactic and Functional, or Tumor. Topics that did not have a dedicated Wikipedia page or that included unrelated topics were excluded from our evaluation.

2.2. Readability assessment and quality evaluation

Our assessment of the readability of the Wikipedia pages is based on five different readability scales. These scales include the Flesch Reading Ease, Flesch-Kincaid Grade Level, Gunning Fog Index, Simple Measure of Gobbledygook (SMOG) Grade level, and Coleman-Liau Index. All of the selected articles were evaluated and scored with each of these readability scales.

The Flesch Reading Ease is a metric that assesses a passage using the total words, total sentences, and total syllables and generates a score that ranges between 0–100 [7]. A passage with a higher score would indicate an article that is easier to read, and a lower score being more difficult. Under this scale, a readability of score of 0–30 indicates a college graduate reading level, 30–50 for college level, 50–60 for 10th–12th grade, 60–70 for 8th to 9th grade, 70–80 for 7th grade, 80–90 for 6th grade, and 90–100 for 5th grade [8]. The Flesch-Kincaid Grade level, Gunning Fog Index, SMOG Grade level, and Coleman-Liau Index are readability scales that assess the educational grade level likely required to comprehend a passage [9]. The Flesch-Kincaid Grade level is evaluated using the same parameters as the Flesch Reading Ease tool [10]. The Gunning Fog Index is calculated using the total number of words, sentences, and complex words (words with 3 or more syllables) [11]. The SMOG index is derived using the total number of poly-syllables and total sentences [12]. The Coleman-Liau Index utilizes the average number of letters and sentences per 100 words [13]. The equation for each of these is listed in Table 1. The readability scores for the Wikipedia pages were generated by applying the plain test of each article into the Readability Test Tool, an online readability calculator by WebpageFX (WebpageFX Inc. Harrisburg, PA). The references in each article were not included as part of the text.

To evaluate the quality, we assessed each of the Wikipedia articles based on the Center for Disease Control (CDC) Clear Communication Index as well as the DISCERN Instrument. The Clear Communication index was developed by the CDC to assess the understanding and clarity of public communication materials [14]. There are four parts to the CDC index, which evaluate a passage on its core features, behavioral

recommendations, use of numbers, and description of risks. Based on these four parts, the passage is given a score between 0 and 100. A score of 90 or higher would indicate the article is clear and easy to understand, and a score of 89 or lower would signify that the written material is not effectively communicated for the intended audience. The DIS-CERN instrument is a tool designed for use by health care professionals and individual consumers to measure the quality of written health information [15]. It is based on a 16-item questionnaire that addresses various quality criteria including reliability, treatment choices, and overall quality of the passage. Each question is scored between 1–5, and a summed total score for the passage will range between 16 and 80. A rating of 5 indicates the passage completely meets the quality criteria, a rating of 2–4 indicates the passage partially meets the criteria, and a rating of 1 to indicate the passage does not meet the criteria. The total score can then be used to categorize the quality as "excellent" (63–80), "good" (51–62), "fair" (39–50), and "poor" (27–38) [16].

2.3. Comparative analysis

We extracted the readability scores for the corresponding AANS pages from a study by Agarwal et al, which conducted an analysis on the online neurosurgical patient information materials [17]. This paper obtained the patient education articles that were available on the AANS website and categorized them into the seven neurosurgical sub-specialties. The articles were then scored for their readability using the Flesch Reading Ease, Flesch Kincaid Grade Level, Gunning Fog Index, SMOG Grade level, and Coleman-Liau Index for their analysis.

2.4. Statistical analyses

Data were tested first for normality using D'Agostino-Pearson omnibus and Shapiro–Wilk tests. Non-normality in distribution was detected for SMOG scores only, all other outcome scores assumed Gaussian distribution. Unpaired two-tailed t-tests with continuity correction was performed for all readability metrics except SMOG. Mann–Whitney U test was used for SMOG. All analysis were performed using GraphPad Prism (GraphPad Software Inc, San Diego, CA).

3. Results

3.1. Articles characteristics

We identified a total of fifty-five Wikipedia articles that corresponded with patient information articles published by the AANS. This constitutes 77.46% of the AANS topics that had related Wikipedia pages. Based on each category, there were 6 "Cerebrovascular" Wikipedia articles (85.7% for total category published by the AANS), 15 articles for the "Spine and Peripheral Nerves" (71.4% for the category), 3 articles for "Neurotrauma and Critical Care" (50% for the category), 8 articles for "Pain" (88.9% of the category), 8 articles for "Pediatric" (80% for the category), 7 articles for "Stereotactic and Functional" (100% of the category), and 8 related to "Tumor" (80% of the category). The scores for each readability test, as well as the CDC Clear Communication Index for the Wikipedia articles are listed in Table 2. All of the Wikipedia articles were last revised between March 2017 and

Table 1
Readability tools and their associated equations.

Readability Tool	Equation
Flesch Reading Ease	$206.835 - 1.015(total\ number\ of\ words/total\ number\ of\ sentences) - 8.46(total\ number\ syllables/total\ number\ of\ words)$
Flesch-Kincaid Grade Level	$0.39(total\ number\ of\ words/total\ number\ of\ sentences) + 11.8(total\ number\ of\ syllables/total\ number\ of\ words) - 15.59$
Gunning Fog Index	$4((total\ number\ of\ words/total\ number\ of\ sentences) + 100(total\ number\ of\ complex\ words/\ total\ number\ of\ words)$
SMOG Index	$1.043\sqrt{total\ number\ of\ polysyllables \times (30/total\ number\ of\ sentences)} + 3.121$
Coleman-Liau Index	$0.0588(average\ number\ of\ letters\ per\ 100\ words) - 0.296(average\ number\ of\ sentences\ per\ 100\ words) - 15.8$