

# Analysis of Internet-Based Written Materials on Surgery for Obstructive Sleep Apnea

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## Abstract

**Objective.** Obstructive sleep apnea (OSA) has many treatment options and the Internet is an important resource for patients. The quality of information reviewed by patients about sleep surgery is unknown. We assessed readability, accessibility, actionability, and quality of online content for OSA surgeries.

**Study Design.** Review of webpages by 2 independent reviewers.

**Setting.** Internet-based search.

**Methods.** We queried Google for sleep apnea surgery and included top 100 English language webpages. Content was scored by 2 reviewers using the Flesch-Kincaid (FK), Simple Measure of Gobbledygook (SMOG), JAMA benchmarks, CDC Clear Communication Index (CCI), and Patient Education Materials Assessment Tool (PEMAT) understandability and actionability scores.

**Results.** Eighty-seven webpages were evaluated including 40 hosted by academic hospitals, 23 private practices, 10 general knowledge, 4 national organizations, 3 industry, 3 non-profit hospitals, and 2 government-sponsored. Mean CCI ranged from 22.7% to 84.9%. No sources met the 90% CCI cutoff. Average PEMAT understandability score was 80.4% ( $\pm 7.8$ ; 62.5%-93.3%), with 91% meeting the 70% standard score. Average PEMAT-actionability score was 38.4% ( $\pm 16.5$ ; 0%-70%), with 5% meeting the standard score. The average readability of webpages was the 10th grade reading level. Only 5% of pages met the recommended 6th grade reading level or lower. Only 21% of pages addressed surgical risks.

**Conclusion.** Most online resources regarding OSA surgery do not meet recommended standards for communication. Providers should be aware of limitations of materials when counseling patients on sleep surgery treatments. Future patient education resources should meet health communication and readability standards.

## Keywords

internet, obstructive sleep apnea, patient education, sleep surgery

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The Internet is an important and frequently used source of health information for patients and their families. In 2022, the Health Information National Trends Survey found an estimated 84.1% of the United States Population uses the Internet with associated search engines as a primary resource for health and medical information.<sup>1</sup> Though the Internet offers a broad knowledge base for patients to access, the quality of available health information varies, and patients are often unaware of the quality and accuracy of the information.<sup>2</sup> Accessibility of web-based information is limited by user education, reading levels, preferred language, and other biases associated with medical information.

Obstructive sleep apnea (OSA) is one of the most common sleep disorders in the United States, with an estimated prevalence of up to 38% of the adult population.<sup>3</sup> Continuous positive airway pressure (CPAP) is first-line medical treatment for OSA. However, patient tolerance of CPAP is variable and, in many patients, adherence is poor.<sup>4</sup> Patients who are CPAP intolerant seek alternative types of treatment, such as mandibular advancement devices, positional therapy, weight loss, or sleep surgery. Adult sleep surgery encompasses a variety of procedures including nasal surgery, soft tissue procedures including palatine tonsillectomy, uvulopalatopharyngoplasty, lingual tonsillectomy, tongue reduction, radiofrequency ablation, and hyoid suspension, hypoglossal nerve stimulator implantation, and maxillomandibular advancement surgery. Sleep surgery is an effective alternative treatment for OSA, with improved cardiovascular and cerebrovascular outcomes compared to no treatment.<sup>5,6</sup> Previous studies with focus groups have

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found that patients with OSA desire more information about CPAP-alternative treatment options from their providers.<sup>7</sup>

Despite the internet being an important source of information for patients who are researching sleep surgery, there is a dearth of information regarding the quality of the online materials available for patients interested OSA surgery. Prior studies have conducted analysis of the quality of internet materials for medical OSA treatment and hypoglossal nerve stimulation and have found the quality of material to be variable and generally lacking.<sup>8-10</sup> However, there has yet to be a review of the quality and comprehensibility of internet-based education materials specific to sleep surgery overall. This study aims to assess the quality and readability of commonly accessed web-based patient education materials on sleep surgery.

## Methods

### Data Sources

Since this study did not involve human subjects or any activities that necessitated ethical review, approval from the University of California, San Francisco (UCSF) Institutional Review Board was not required. We used Google (<http://google.com>) as our internet search engine for our analysis of online patient education materials for sleep surgery. Searches for “sleep apnea surgery” were performed on July 20, 2023. After deleting the history and cookies and disabling location services on the browser, searches were conducted using the United States version of Google. We conducted a similar search on Bing (<https://www.bing.com>) and Yahoo (<https://www.yahoo.com>) and found a large degree of overlap between search results across engines, hence used the top 100 Google search engine results.

### Webpage Selection

The first 100 English language webpages providing information on sleep surgery on Google's search engine were identified. Webpages that required registration or subscription, duplicate pages, webpages addressing only nonsurgical CPAP alternatives, and pages intended for medical professionals were excluded from analysis.

### Evaluation of Readability and Quality of Webpages

Webpage hosts were next classified into 1 of 7 categories: academic hospital, general knowledge (ie, Wikipedia, WebMD), government, industry, national organization, not-for-profit hospital, and private practice. The reading level of sleep surgery webpages was evaluated using 3 readability measures: the Flesch Reading Ease Score (FRES), the Flesch-Kincaid (F-K) Grade Level, and the Simple Measure of Gobbledygook (SMOG).<sup>11-13</sup> The FRES is scored on a scale of 0 to 100 and is based on the average number of words per sentence and syllables per word; it is built into many word processing programs to

measure readability. The F-K grade level indicates the years of education or U.S. grade level required to understand the material. Higher FRES scores indicate material that is easier to read; a FRES score of 70 to 80 indicates that the material is quite easy to read versus a score of 30 to 50 indicates difficult-to-read material. A higher F-K grade level indicates that the material is more difficult to understand. The SMOG score uses word and sentence length to measure the reading ease of material and higher SMOG scores indicate a more difficult text in terms of readability. The American Medical Association (AMA) recommends patient education materials to be written at or below a sixth-grade reading level to meet the needs of the general public.<sup>14</sup>

Two authors (A.B. and W.N.) rated the quality of information provided by the webpages using 3 health communication assessments: the *Journal of the American Medical Association* (JAMA) benchmarks, the CDC Clear Communication Index (CCI) and the Patient Education Materials Assessment Tool (PEMAT).<sup>15-17</sup> The JAMA benchmarks assess credibility of internet materials using standards of authorship, attribution (references), disclosure of conflicts of interest, and currency (date of last update) and are graded on a range of 0 to 4. The CDC CCI is a 20-item index for assessing the clarity of health communication materials through assessment of the material's main message and call to action, language, information design, state of the science, behavioral recommendations, numbers, and risk. The CCI is scored on a scale of 100, with a score of 90 meeting recommended standards. The PEMAT is a 24-item tool used to assess understandability and actionability of print and audiovisual materials; it is divided into 2 parts: the PEMAT-Understandability (PEMAT-U) and the PEMAT-Actionability (PEMAT-A). Scores on the PEMAT are scaled from 0 to 100%, with scores above 70% indicating that the material is sufficiently understandable or actionable.

Aside from using existing quality assessment metrics, the raters also assessed each webpage for the presence of information addressing the risks of sleep surgery and expected recovery and outcomes.

### Statistical Analysis

The scores assigned by the 2 raters were used to calculate descriptive statistics for each webpage. The percentage of webpages that met the target grade level, CCI, and PEMAT cutoff scores was calculated. All statistical analyses were performed on R (version 4.3.1) and values with  $P < .05$  were considered statistically significant.<sup>18</sup>

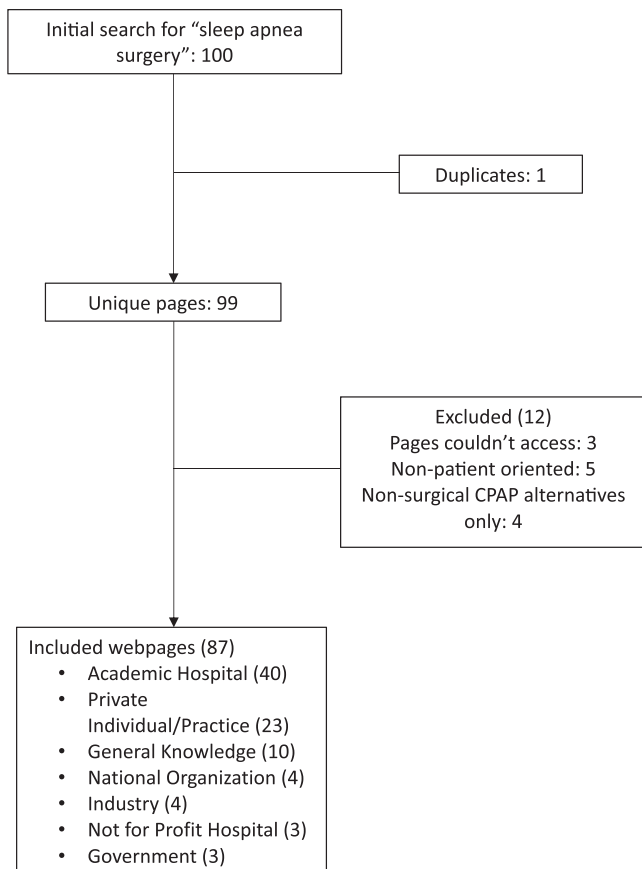
## Results

Based on inclusion and exclusion criteria, 87 webpages were identified (**Figure 1** and Supplemental File S1, available online) and graded using the FRES, F-K Grade Level, SMOG, JAMA benchmarks, CCI, and PEMAT.

The intra-class coefficients for JAMA benchmark (0.90), CCI (0.44), PEMAT- U (0.43), and PEMAT-A (0.36) scores suggested a moderate to high level of agreement between the raters. Of all the hosted webpages, academic hospital (46%) and private practice (26%) hosted pages made up the majority of the search results (**Figure 1**).

### Readability Scores

The mean F-K Grade level for all webpages was  $10.5 \pm 2.6$  (mean reading grade level = 10th grade), the mean FRES was  $43.5 \pm 15.1$  (difficult to read) and the mean SMOG was



**Figure 1.** Search results and selection of webpages providing information on sleep surgery.

$15.2 \pm 3.7$  (15 years of schooling required) (**Table 1**). Only 4 sites (5%) met the recommended 6th grade reading level: 1 academic hospital webpage, 1 general knowledge webpage, 1 not-for-profit hospital webpage, and 1 industry webpage.<sup>19-22</sup>

### Content Assessments

The mean JAMA benchmark score was  $1.3 \pm 1.2$ , the mean CCI score  $58.8 \pm 12.5$ , the mean PEMAT-understandability score  $80.4 \pm 7.8$ , and the mean PEMAT actionability score  $38.4 \pm 16.5$  (**Table 2**). Significant differences in JAMA Benchmark scores were found with academic hospital webpages scoring significantly lower than general knowledge ( $0.7 \pm 0.5$  vs  $3.4 \pm 0.4$ ,  $P < .01$ ), industry ( $3.0 \pm 1.1$ ,  $P = .02$ ), and government pages ( $2.7 \pm 0.3$ ,  $P < .01$ ). Two webpages received 4 out of 4 points on the JAMA benchmark criteria scale; 1 page belonged to the general knowledge category (Medscape) and the other was industry-sponsored (GoodRx Health).<sup>23,24</sup>

National organization webpages had significantly greater CCI scores compared to academic hospital webpages ( $69.7 \pm 5.1$  vs  $58.8 \pm 12.5$ , **Table 2**), but no other categories had significant differences with academic hospital webpages for CCI scores. The CCI scores ranged from 22.7 to 84.9 with higher scores indicating greater clarity in communication materials. None (0%) of the webpages met the 90% CCI cutoff score for effective and clear health communication materials (**Table 3**). The webpage that was rated with the highest CCI score belonged to the industry category (GoodRx Health).<sup>24</sup>

General knowledge webpages had significantly greater PEMAT understandability scores when compared to academic hospital sites ( $85.3 \pm 6.2$  vs  $79.8 \pm 7.3$ ,  $P = .03$ , **Table 2**). The PEMAT understandability scores ranged from 62.5 to 93.3%. Overall, 91% of sites met the recommended 70% score standard (**Table 3**).

The PEMAT actionability scores ranged from 0 to 70%. The industry and national organization webpages were significantly more actionable than the academic hospital webpages in terms of their PEMAT actionability scores (**Table 2**). Only 5% of webpages met the recommended standard for 70% for PEMAT actionability scores (**Table 3**).

**Table 1.** Readability Scores of Webpages on Sleep Surgery

Webpage category	F-K Grade Level	FRES	SMOG
Academic Hospital (n = 40)	$11.1 \pm 2.9$	$39.2 \pm 17.0$	$16.6 \pm 4.4$
Private Individual/Practice (n = 23)	$10.6 \pm 1.4$	$44.3 \pm 8.2$	$14.3 \pm 1.7$
General Knowledge (n = 10)	$9.7 \pm 2.1$	$47.8 \pm 14.8$	$14.3 \pm 2.9$
National Organization (n = 4)	$10.1 \pm 1.8$	$45.8 \pm 9.7$	$14.3 \pm 1.7$
Industry (n = 4)	$8.9 \pm 2.3$	$52.9 \pm 12.7$	$12.7 \pm 1.9$
Not For Profit Hospital (n = 3)	$7.9 \pm 3.5$	$59.4 \pm 14.4$	$12.2 \pm 2.5$
Government (n = 3)	$9.3 \pm 5.3$	$48.6 \pm 26.1$	$14.5 \pm 4.8$
Total (n = 87)	$10.5 \pm 2.6$	$43.5 \pm 15.1$	$15.2 \pm 3.7$

Scores reported as mean  $\pm$  SD.

**Table 2.** Quality, Understandability, and Actionability of Content of Webpages Providing Information on Sleep Surgery

Webpage category	JAMA benchmark	CCI	PEMAT understandability	PEMAT actionability
Academic Hospital (n = 40)	0.7 ± 0.5	58.4 ± 11.3	79.8 ± 7.3	34.9 ± 13.8
Private Individual/Practice (n = 23)	0.7 ± 0.5 (0.5)	53.8 ± 14.2 (0.19)	77.2 ± 8.6 (0.23)	42.2 ± 15.9 (0.08)
General Knowledge (n = 10)	3.4 ± 0.4 (<0.01)*	60.2 ± 10.9 (0.65)	85.3 ± 6.2 (0.03)*	29.0 ± 19.1 (0.37)
National Organization (n = 4)	2.4 ± 1.4 (0.09)	69.7 ± 5.1 (0.01)*	83.1 ± 4.5 (0.25)	52.5 ± 9.6 (0.03)*
Industry (n = 4)	3.0 ± 1.1 (0.02)*	70.4 ± 10.8 (0.10)	84.9 ± 3.7 (0.06)	55.0 ± 5.8 (<0.01)*
Not For Profit Hospital (n = 3)	1.2 ± 1.2 (0.52)	59.0 ± 14.3 (0.95)	84.4 ± 11.8 (0.57)	50.0 ± 20.0 (0.32)
Government (n = 3)	2.7 ± 0.3 (<0.01)*	67.4 ± 11.5 (0.31)	81.7 ± 8.3 (0.73)	33.3 ± 30.6 (0.94)
Total (n = 87)	1.3 ± 1.2	58.8 ± 12.5	80.4 ± 7.8	38.4 ± 16.5

Data are presented as mean ± standard deviation. *P* values in (), based on comparison to academic hospital scores.

\*Values with *P* < .05 considered significant.

**Table 3.** Percentage of Webpages on Sleep Surgery Meeting Recommended Quality Standards

	Recommended standard	Percent of sites that Met standard (%)
Grade level	6th grade	5%
CCI	90%	0%
PEMAT	70%	91%
understandability		
PEMAT actionability	70%	5%
Addressed risks of surgery	--	21%

Only 21% (n = 18) of webpages explicitly addressed surgical risks. Of these, 6 were general knowledge, 5 were academic hospital pages, 2 were government sponsored, 2 were not-for-profit hospital pages, 1 was industry, 1 was a national organization page, and 1 was a private practice webpage.

## Discussion

This study evaluated the readability, and quality of webpage content on adult sleep surgery and found that most web-based materials do not meet recommended patient education quality and readability standards. Of the 87 sites included, most did not meet established standards for readability and actionability, although most did meet standards of understandability (PEMAT). Most webpages did not address risks and/or prognosis of sleep surgery options which are important considerations for patients researching sleep surgery options.

The majority of the included webpages analyzed belonged to academic hospitals. We did not find significant differences between academic webpages and other webpage categories in terms of most quality and readability metrics. No single webpage we reviewed excelled in all readability and quality ratings nor met recommended standards for readability and communication metrics. SleepEducation.org received the best overall scores, with information at an 8th grade reading level

and a greater than 70% PEMAT understandability and actionability score, although it did not meet the CCI standard (CCI metric score 75).<sup>25</sup> Notably, SleepEducation.org was hosted by a national organization, the American Academy of Sleep Medicine Foundation (AASM).

The implications of these results indicate that online materials may require higher education and reading levels and do not meet communication standards, resulting in limited utility for accessible and broad patient education. Poor design of patient education materials is particularly detrimental to patients with low health literacy. Eighty million adults in the United States are estimated to have low or limited health literacy. Low health literacy is associated with older age, lower socioeconomic status, lower levels of education, non-native English speakers, and those who have chronic conditions, such as OSA.<sup>26</sup> Patients who have more difficulty navigating health information and the health care system have been found to have increased hospitalization rates and higher mortality rates.<sup>27</sup>

The internet remains an important source of health information for many patients; patients use online medical information to prepare for visits and assist in the healthcare decision making process.<sup>28</sup> Therefore, it is essential that online information on sleep surgery is accurate and accessible to patients. Web-based education materials should be designed to meet readability and communication standards for patients. Otolaryngologists should be knowledgeable about the lack of high-quality online content on sleep surgery.

Our study has some limitations. First, we limited our study to a single search term when conducting a review of online materials on sleep surgery. Second, although we had 2 reviewers use validated health communication tools to assess resources for sleep surgery education materials, there is a degree of subjectivity that may have influenced our results. Third, unlike previous studies on online education material quality, we did not use Health on the Net Foundation (HON) certification in our analysis due to its permanent discontinuation as of December 2022. Fourth, we only assessed English language sites in this analysis which may limit the applicability of our conclusions outside of English-based materials.

## Conclusions

In conclusion, we found that many web-based education materials on sleep surgery do not meet quality or readability standards. Given the growing interest in sleep surgery treatment options for OSA, accessible and high-quality online education materials are needed that address surgery types, risks, and expectations for recovery and outcomes. Web-based education materials should be designed to meet readability and communication standards for patients.

## Author Contributions


**Amrita Bhat**, data collection, data analysis and interpretation, drafting the article, critical revision of the article. **William Nesmith**, data collection, data analysis and interpretation, critical revision of the article. **Megan L. Durr**, Conception and design of the work, data collection, data analysis and interpretation, critical revision of the article. **Jolie L. Chang**, Conception and design of the work, data collection, data analysis and interpretation, critical revision of the article.

## Disclosure

**Competing interests:** J.L.C. is supported by the Veterans Affairs Medical Center, San Francisco, CA. The contents do not represent the views of the U.S. Department of Veterans Affairs or those of the U.S. government. J.L.C. is also a consultant for Inspire Medical Systems and for Nyxoah. The authors have no other funding, financial relationships, or conflicts of interest to disclose.

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