Reducing the Use of Complex Words and Reducing Sentence Length to < 15 Words Improves Readability of Patient Education Materials Regarding Sports Medicine Knee Injuries

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Introduction and Purpose

- Sports-related knee injuries such as anterior cruciate ligament (ACL) or meniscus tears are very common.
- Approximately 50% of internet users have reported using the internet to learn more information about a specific medical treatment or procedure.
- The internet's usefulness is dependent not only on the content available to patients, but also the health literacy of the patient consuming the information.
- Poor health literacy is associated with poor outcomes.
- The NIH and AMA recommend that online patient resources be written at or below the sixth-grade reading level.
- Online PEMs in Orthopaedics have consistently been shown to be written above the NIH-recommended sixth-grade reading level to the detriment of patient health literacy.
  - "A 2018 analysis of the readability of 39 AAOS Sports Med PEMs found that all PEMs were written above the 6th-grade reading level with 36% written above a 12th-grade reading level." (PMID: 30480008)
- While many studies have suggested strategies to improve the readability of PEMs, literature describing the benefit of these proposed changes is scarce.
- The purpose of this study is to develop a standardized method to improve readability of Orthopaedic PEMs without diluting their critical content by reducing the use of complex words (> 3 syllables) and shortening sentence length to < 15 words.

Methods

- OrthoInfo was queried for PEMs relevant to the care of athletic injuries of the knee.
- Inclusion criteria were PEMs that were unique, pertained to topics of knee pathology in sports medicine, and written in a prose-format.
- A total of 205 PEMs were available for review. 23 PEMs met inclusion criteria for this study.
- Readability of PEMs was evaluated using seven unique readability formulas before and after applying a standardized method to improve readability while preserving critical content. Readability scores were determined using the Automatic Readability Checker on www.readabilityformulas.com.
- Application of the standardized method for improving readability, as well as preservation of critical content were performed by upper-level medical students interested in Orthopaedic Surgery.
- Paired samples t-tests were conducted to assess the relationship between reading levels of the original PEMs and reading level of edited PEMs.
- P-values ≤ 0.05 was deemed statistically significant.

Results and Discussion

	Original PEMs		Edited PEMs			
READABILITY FORMULA	MEAN	*STD DEV*	MEAN	*STD DEV*	CHANGE IN MEAN	P-VALUE
Flesch Reading Ease Score	52.9	*6.9*	68.8	*5.6*	15.9	**p = 5.5E-13**
Gunning Fog	12.7	*1.7*	8.6	*1.4*	-4.1	**p = 1.5E-13**
Flesch-Kincaid Grade Level *	9.8	*1.4*	6.4	*1.1*	-3.4	**p = 1.9E-13**
The Coleman-Liau Index	11.7	*1.0*	10.0	*0.8*	-1.7	**p = 5.2E-09**
The SMOG Index	9.6	*1.2*	6.8	*1.0*	-2.9	**p = 1.0E-12**
Automated Readability Index	9.9	*1.6*	6.3	*1.2*	-3.6	**p = 1.5E-13**
Linsear Write Formula	10.2	*2.1*	5.9	*1.1*	-4.3	**p = 2.0E-12**

PEMs = Patient Education Materials; SMOG = Simple Measure of Gobbledygook; STD DEV = Standard Deviation

Table 1: Readability scores of seven independent readability formulas for original versus edited PEMs.

- Reading levels differed significantly between the 23 original PEMs and edited PEMs across all seven readability formulas ($p \leq 0.05$).
- Mean Flesch Kincaid Grade Level of original PEMs (9.8 ± 1.4) was significantly increased compared to that of edited PEMs (6.4 ± 1.1) ($p \leq 0.05$).
- 4.0% of original PEMs met NIH recommendations of a sixth-grade reading level compared to 48.0% of modified PEMs.

	Original PEMs		Edited PEMs			
MEASUREMENT	MEAN	*STD DEV*	MEAN	*STD DEV*	CHANGE IN MEAN	P-VALUE
Number of words (total)	1351.7	*600.3*	1215.5	*584.4*	-136.2	**p = 0.00042**
Number of words per sentence	15.8	*2.4*	11.1	*1.7*	-4.7	**p = 5.8E-12**
Mean characters per word	5.0	*0.2*	4.7	*0.1*	-0.3	**p = 3.3E-11**
Mean syllables per word	1.9	*0.3*	1.5	*0.5*	-0.4	**p = 0.23**
% of 3+ syllable words	17.60%	*3.10%*	11.70%	*2.80%*	5.9%	**p = 7.2E-10**
# of 3+ syllable words	242.2	*129.1*	146.6	*100.2*	-95.6	**p = 1.3E-7**

PEMs = Patient Education Materials; STD DEV = Standard Deviation

Table 2: Composite descriptive statistics comparing original versus edited PEMs included in this present study.

- The mean number of words per sentence was measured to be 15.8 ± 2.4 for original PEMs versus 11.1 ± 1.7 for edited PEMs ($p \leq 0.05$).
- Percentage of complex words was measured to be $17.6\% \pm 3.1\%$ for original PEMs compared to $11.7\% \pm 2.8\%$ for edited PEMs ($p \leq 0.05$).

Conclusions

- **This standardized method improves readability of PEMs across all seven readability formulas.**
- **This is a clinically impactful finding as improving the readability of PEMs directly translates to enhanced patient health literacy which can lead to better patient outcomes.**
- **The simplicity of the method allows for it to easily be applied to all areas of Orthopaedics, as well as other specialties within medicine, to improve health literacy on a wider scale.**
- **Orthopaedic organizations and institutions should consider improving the readability of their materials by using this standardized method when developing PEMs.**
- **Further studies will focus on objectively assessing comprehension in a clinical setting to determine the clinical significance of this improved readability.**