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PROFESSIONAL ISSUES

Tools for Assessing Readability and Quality of Health-Related Web Sites

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Abstract With the Internet becoming a growing source of information on genetics, genetic counselors and other health-care providers may be called upon to guide their patients to appropriate material, which is written at a suitable reading level for the individual and contains quality information. Given that many health-related Web sites are written at a high school or higher reading level, without direction from a genetic counselor or health-care provider, many Internet users may currently be turning to health-related Web sites that they do not understand. Additionally, Internet users may not know how to evaluate the quality of information they find, which could lead to them access inaccurate or irrelevant information. To aid in the process of finding and designing Web sites that are appropriate for patients, the current article provides guidelines for assessing readability and quality of health-related content. Additionally, a demonstration of an assessment is provided. Finally, limitations of these assessments are discussed.

Keywords Web sites · Internet · Readability · Quality · Health information

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Introduction

According to the National Society of Genetic Counselors' Task Force Report, a key goal of genetic counseling is to help people understand genetic contributions to disease (Resta et al. 2006). Genetic counselors serve as a resource for the general public, patients, and other health care professionals (National Society of Genetic Counselors 2008). The Internet provides an opportunity for genetic counselors, as well as other health-care providers, to educate individuals about genetics, genetic diseases, and broader health concerns. According to the DMOZ Open Directory Project (2008), there are over 64,000 health-related Web sites and lists currently online; of these, nearly 700 are dedicated to genetic disorders. Supporting the role of the Internet in genetics education, studies have found that people are increasingly turning to the Internet first in their search for genetics information (e.g., Case et al. 2004; Fisher et al. 2005). A recent Pew study (2006) found 80% of adult Internet users in America have sought health

information on the Internet. Another study found that nearly half of the medical genetics patients surveyed used the Internet to research genetics prior to their appointments (Taylor et al. 2001).

Readability and Literacy

Genetic counselors and other health-care providers can play a role in developing and monitoring genetic information provided to patients, guiding them to information that is appropriate and beneficial for the specific individuals. The extent to which the Internet provides useful information depends highly on the readability (i.e., ease of reading) of the information communicated. The average reading level in the United States is around the 8th grade level, though many individuals read below this level (e.g., Cotugna et al. 2005). Thus, to reach the widest audience, material should be written at around a 5th grade reading level (Doak et al. 1996; Weiss 1998). Unfortunately, health-related materials are commonly written at a 10th grade reading level or higher (e.g., Cotugna et al. 2005; Friedman and Hoffman-Goetz 2007; Friedman et al. 2004; Kaphingst et al. 2006), making the information inappropriate for a diverse audience.

Beyond literacy, health literacy is "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" (U.S. Department of Health and Human Services 2000). A 2003 National Assessment of Adult Literacy found that one-third of adults are in the range of basic or below basic health literacy. These individuals struggle with tasks that involve searching for specific information in complex materials, making inferences about the information they have, and understanding and using quantitative information. Not surprisingly then, nearly half of the American adult population has difficulties understanding and using health information (Paasche-Orlow et al. 2005).

Quality of Information

In addition to readability, the quality of the information communicated through the Internet is of critical concern. Quality can take on many meanings, and for health information on Web sites it is frequently characterized by the disclosure and qualifications of authors, sponsorship and funding sources, attributions; statements regarding privacy and confidentiality concerns; current, clear content that is balanced and provides an unbiased portrayal of choices and alternatives. Though quality should be a large concern when communicating health information on the Internet, it is not clear that adequate attention is paid to quality indicators in the development of Web sites. In a review of studies that examined the quality of health-related Web sites, 70% of the studies concluded that the quality of information was inadequate, as indicated by failure to meet quality criteria selected by each individual study (e.g., disclosure of authorship, disclosure of creation data, provision of references), using various scoring systems (e.g., DISCERN; Eysenbach et al. 2002). Fortunately, some research has suggested an incline in the number of sites adhering to quality criteria (Meric et al. 2002).

Despite the positive trend in Web sites quality, there does not appear to be a relationship between Web sites' popularity and their quality or accuracy (Meric et al. 2002). On their own, patients may access information that is not credible, accurate, or appropriate for them, which may lead to confusion and poor decision making (Guttmacher 2001). For instance, 75% of Internet users fail to consider the recency of the information they find (Pew Internet and American Life Project 2006). Of course, checking for these quality indicators is not often easy; the U.S. Department of Health and Human Services found that only 4% of frequently visited health-related Web sites offered the source of their information (Pew Internet and American Life Project 2006).

Given the opportunity, genetic counselors and other health-care providers should be prepared to guide their patients in information seeking, particularly on the Internet, by offering direction to readable and higher-quality Web sites. The goal of this paper is to review available methods to evaluate the readability and quality of genetics-related Web sites. While discussed in the context of genetics, the tools may also be applied on a broader level to other health-related Web sites. With these tools to evaluate Web sites, genetic counselors and other health-care providers can help their patients and the public access readable, high quality information regarding health and genetics. With access to better information, patients can increase their knowledge about genetics, as well as other health concerns, and consequently, make more informed decisions regarding their health.

Evaluating Genetics Web Sites

Assessing Readability

Readability can be calculated by hand, by computer software program, or online, using a variety of readability formulas. These formulas serve to assess the difficulty level of reading materials by examining factors such as word length, sentence length, and complexity of vocabulary (Friedman and Hoffman-Goetz 2006). Overall, shorter words and shorter sentences, paired with no or few complex terms, are associated with a higher readability level, or higher reading ease (Doak et al. 1996). Some formulas

consider short words to be those that contain few syllables (e.g., SMOG Index: Mclaughlin 1969), while other formulas describe short words to be those that contain few characters (e.g., Automated Readability Index; Smith and Senter 1967). Using letters, rather than syllables, is considered easier to calculate when evaluating readability by hand, but it may be debatable whether words with fewer characters or fewer syllables are easier to read and understand. Table 1 provides a variety of readability formulas, along with how to employ them. The table is not an exhaustive listing of all readability formulas; the list was generated based on all formulas that were mentioned in the first ten relevant hits in online searches (i.e., www.google.com and www.yahoo.com) using the search term "readability formula".

Many of the formulas can be applied to 100-word samples from the text or the entire text. Analyzing the entire text will produce a more accurate readability score, while analyzing a representative sample will offer a quicker assessment of readability of the text. When calculating readability on the computer, it is sometimes necessary to edit the text. The online tools and software provide specific editing instructions when applicable. Editing instructions typically involve removing non-words (i.e., such as symbols and abbreviations), links to other Web sites/PDF files, and text in foreign languages. Microsoft Word offers readability assessment using Flesch–Kincaid Grade Level and Flesch Reading Ease scores. However, although Flesch–Kincaid Grade Level scores may range into graduate school level, Microsoft Word artificially limits scores to the 12th grade, thus underestimating actual readability compared to other readability assessment programs, such as Readability Calculations (Hochhauser 2002), as well as WordPerfect (Hochhauser 2002; Paasche-Orlow et al. 2003). In general, it is important to be aware of the assumptions made by the program used to assess readability, in order to better understand the scores that are produced and their potential limitations.

Because shorter, more common words are associated with higher readability, medical terms that are polysyllabic (e.g., inherited thrombophilia) may inflate the readability score, making text seem harder to read than it actually may be. For individuals who are at least familiar with the name of the disease, such long medical terms may not detract from the readability of information. Scores provided by readability formulas will not be sensitive to readers' prior knowledge or motivation (Bailin and Grafstein 2001). Thus when evaluating the readability of a Web site, it is important to go beyond the score, and incorporate the knowledge the would-be Web site viewer already possesses. In short, in the assessment of readability, having a score or multiple scores is only one piece of the puzzle; it is also valuable to consider individual consultands' or patients' knowledge and what reading level.

Assessing Quality

Quality can be assessed based on a set of criteria, and a variety of tools exist to assess quality of Web sites. Some common guidelines focus on content of the site, including reliability, currency, and appropriateness for the intended audience; authority of the source, including disclosure of the authors and credentials; accessibility and availability; design; links; user support, including contact information or an outlet for Internet users to give feedback; and confidentiality (e.g., Kim et al. 1999; Provost et al. 2006). Many quality guidelines offer indirect verification of characteristics. For instance, some guidelines imply that information that is current and cited is also reliable and accurate. Authors that appear qualified and objective are assumed to be trustworthy and credible. Table 2 provides an overview of several guidelines for evaluating quality, including their goals, the audience for which they were designed, their general criteria, and a Web address to find their specific criteria checklist. The table is not an exhaustive listing of all quality guidelines. The list was generated based on quality criteria and guidelines that were mentioned in the first ten relevant hits in an online search (i.e., www.google.com and www.yahoo.com) using the search term "quality of health Web sites" and "quality of health information"; additionally some criteria were included based on discussion with colleagues.

Highly recommended is the Health on the Net's Code of Conduct (HONCode), a well-established tool for evaluating health-related Web sites. It provides thorough explanation of its criteria, which is helpful in making judgments about a Web site. Additionally, it uniquely offers accreditation for Web sites that comply with the quality criteria; Web sites that fulfill the necessary criteria can display the HONCode logo, which can be a helpful indicator to those who visit the site because it serves as a quick, reliable evaluation of quality. HONCode's Web site offers a downloadable toolbar that can be added to a Web browser; the toolbar checks the accreditation of the Web site being viewed and allows Internet users to search the HON database of accredited Web sites (http://www.hon.ch/HONcode/Plugin/Plugins.html). However, it is notable that continued compliance with the HONCode is not strictly enforced (Meric et al. 2002). The DISCERN is also recommended due to its ease of use; it is best employed when evaluating Web sites related to treatment decisions. For Web sites on genetic testing and screening, the DISCERN provides a genetics-specific tool (http://www.discern-genetics.org).

The QUICK tool, as it name suggests, is also an easy tool to use, as it was designed for use by children. However, its ease of use comes at a cost; unlike HONCode and DISCERN it was not designed specifically for health-related Web sites, thus making it less suitable for evaluating such

Table 1 Readability Formulas

Formula	Where to find	How to calculate	Interpreting Scores
SMOG Index (Mclaughlin 1969)	• Online (online-utility.org/English/readability_test_and_improve.jsp; harrymclaughlin.com/SMOG.htm; readability.info/) • Software (Readability Calculations, Readability Studio)	1. Take a 10-sentence passage from the beginning, middle, and end of the text 2. Count the words with 3 or more syllables 3. Estimate the square root (i.e., round to the nearest perfect square) of step 2 4. Add 3 to result from step 3	Reading grade level necessary for a person to have reached in order to fully understand text
Gunning FOG Index (Gunning 1952)	• Online (semantia.com.au/tools/readcal/calculator.php; online-utility.org/english/readability_test_and_improve.jsp; streamer.rit.edu/~jeffs/services/TestReadability.html; juicy studio.com/services/readability.php; readability.info/;) • Software (Readability Calculations, Readability Studio, Grammatik IV)	1. Divide number of words by number of sentences (ASL) 2. Compute percentage of words with 3 or more syllables, excluding proper nouns, compound words or words with common suffixes as a syllable, and familiar jargon (PPSW) 3. Use formula: $(ASL + PPSW) \times 0.4$	Years of formal education that a person requires in order to easily understand the text on the first reading
Powers–Sumner–Kearl Formula (Powers et al. 1958)	• Software (Readability Calculations, Readability Studio)	1. Take a 100-word sample 2. Divide number of words by number of sentences (ASL) 3. Divide number of syllables by 100 (NS) 4. Use formula: $(ASL \times 0.0778) + (NS \times 0.0455) - 2.2029$	Years of education required to understand most of the text
FORCAST Formula (Ford et al. 1992)	• Software (Readability Calculations, Readability Studio)	1. Take a 150-word sample of the text 2. Count the number of monosyllabic words and divide this total by 10 3. Subtract result in step 2 from 20	Years of education required to understand most of the text
Automated Readability Index (ARI) (Smith and Senter 1967)	• Online (online-utility.org/english/readability_test_and_improve.jsp; readability.info/) • Software (Readability Studio)	1. Divide number of characters by number of words (AWL) 2. Divide number of words by number of sentences (ASL) 3. Use formula: $(4.71 \times AWL) + (0.5 \times ASL) - 21.43$	Years of education required to understand most of the text
Flesch–Kincaid Grade Level (Kincaid et al. 1975)	• Online (standards-schmandards.com/exhibits/rix; semantia.com.au/tools/readcal/calculator.php; online-utility.org/english/readability_test_and_improve.jsp; streamer.rit.edu/~jeffs/services/TestReadability.html; juicystudio.com/services/readability.php; readability.info/) • Software (Readability Calculations, Readability Studio, Grammatik IV) Microsoft Word, Word Perfect	1. Divide number of words by number of sentences (ASL) 2. Divide number of syllables by number of words (ASW) 3. Use formula: $(0.39 \times ASL) + (11.8 \times ASW) - 15.59$	Years of education required to understand most of the text
Flesch Reading Ease Formula (Flesch 1948)	• Online (standards-schmandards.com/exhibits/rix, semantia.com.au/tools/readcal/calculator.php, streamer.rit.edu/~jeffs/services/TestReadability.html; juicystudio.com/services/readability.php; readability.info/) • Software (Readability Calculations, Readability Studio, Grammatik IV) • Microsoft Word, Word Perfect	1. Divide number of words by number of sentences (ASL) 2. Divide number of syllables by number of words (ASW) 3. Use formula: $206.835 - (1.015 \times ASL) - (84.6 \times ASW)$	Scores range from 0 to 100, higher scores indicate greater reading ease, 6≈8th grade reading level

Table 1 (continued)

Formula	Where to find	How to calculate	Interpreting Scores
Bormuth (Bormuth 1969)	• Software (Degrees of Reading Power)	1. Divide number of characters by number of words (AWL) 2. Divide number of words listed in Dale and Chall (1995) 3,000 familiar word list by the number of words total (AFW) 3. Divide number of words by number of sentences (ASL) 4. Use formula: $0.886593 - (AWL \times 0.03640) + (AFW \times 0.161911) - (ASL \times 0.21401) - (ASL \times 0.000577) - (ASL \times 0.000005)$	Years of education required to understand most of the text
New Dale–Chall (Dale and Chall 1995)—for text higher than 3rd grade level	• Software (Readability Calculations, Readability Studio) • List of 3,000 Familiar Words: http://www.rfp-templates.com/Dale-Chall-List-of-3000-Simple-Words.html	1. Take a 100–150 word sample of the text 2. Divide number of words by number of sentences (ASL) 3. Compute percentage of words not on the list of 3,000 familiar words (i.e., difficult words: PDW; see Dale and Chall 1995) 4. Use formula: $(0.0496 \times ASL) + (0.1579 \times PDW) + 3.6365$ 5. Use raw score from step 5 to calculate grade level in table (Dale and Chall 1995)	Years of education required to understand text above the 3rd grade
Spache (Revised: Spache 1974)—for text at or below 3rd grade level	• Software (Readability Calculations, Readability Studio)	1. Take a 100–150 word sample of the text 2. Divide number of words by number of sentences (ASL) 3. Compute percentage of words not on the list of familiar words (PDW; see Spache 1974) 4. Use formula: $(0.141 \times ASL) + (0.086XPDW) + 0.839$	Years of education required to understand text through the 3rd grade
Coleman–Liau Grade Level	• Online (readability.info/) • Software (Readability Studio)	1. Divide number of characters by number of words (AWL) 2. Divide number of words by number of sentences (ASL) 3. Use formula: $(5.89 \times (AWL/ASL)) - (30 \times (number\ of\ sentences/ASL) - 15.8$	Years of education required to understand most of the text
Fry Graph (Fry 1968)	• Software (Readability Calculations, Readability Studio) • Graph: school.discoveryeducation.com/schrockguide/fry/fry2.html	1. Take a 100-word passages from the beginning, middle, and end of the text 2. Divide the number of sentences by 3 3. Divide the number of syllables by 3 4. Use the results from step 2 and 3 to estimate grade level from Fry Graph for Estimating Readability (Fry 1968)	Years of education required to understand most of the text
Raygor Estimate Graph (Raygor 1977)	• Software (Readability Studio) • Graph: oleandersolutions.com/raygorgraph.html	1. Take a 100-word passages from the beginning, middle, and end of the text 2. Count the number of sentences 3. Count the number of words with six or more letters 4. Use the results from step 2 and 3 to estimate grade level from Raygor Graph	Years of education required to understand most of the text
Linsear Write (developed by the Air Force for evaluating technical manuals)	• Software (Readability Studio)	1. Count number of words with two or fewer syllables 2. Count number of words with three or more syllables 3. Multiply result in step 2 by 3 4. Add results from step 1 and step 3 5. Divide result from step 4 by number of sentences 6. If result from step 5 is larger than 20 divide by 2; if result is less than or equal to 20 subtract 2 and divide by 2	Years of education required to understand most of the text

Table 2 Quality Guidelines

	HONCode[a]	DISCERN[b]	QUICK[c]	WebWatch[d]	Judge Project[e]	eEurope2002[f]	IQ Tool[g]	Children's Partnership[h]
Goals/purpose								
Set ethical standards for presentation of health information	✓							
Provide standardized criteria to consistently evaluate the quality		✓	✓		✓		✓	✓
Standardize reliability of health-related Web sites.	✓							
Raise the quality of information on Web sites	✓				✓			
Help consumers choose and use health-related Web sites	✓	✓	✓	✓	✓	✓		
Guide the development of health-related Web sites	✓			✓	✓			
Assess impact of inaccurate/unreliable information		✓						
Developed for...								
Web site developers and publishers	✓			✓	✓			✓
General Internet users, general public, health consumers	✓	✓		✓	✓	✓	✓	
Community-based organizations								✓
Children			✓					
Health educators or health care providers/clinicians						✓		
Criteria for quality evaluation								
Is it clear who the author of the site is?	✓		✓		✓	✓	✓	✓
Is the author qualified?	✓				✓	✓	✓	
Can the author be easily contacted?				✓	✓	✓	✓	✓
Does information complement the doctor/patient relationship?	✓							
Is the site respectful of individual information (e.g. identity)?	✓				✓	✓	✓	✓
Are sources and references revealed?	✓	✓			✓	✓	✓	
Are claims supported and verifiable?	✓		✓		✓			
Is evidence current?		✓		✓	✓			✓
Are additional sources offered?		✓			✓			
Does the site identify when it was created, last updated, etc?			✓		✓	✓	✓	✓
Is there an area to provide feedback or participate in dialogue?					✓			✓
Is the site upfront about its sources of sponsorship and funding?	✓			✓	✓		✓	✓
Is material differentiated from advertising?	✓			✓				✓
Is there a clear, stated purpose?		✓	✓	✓	✓	✓		✓
Does the material achieve the purpose?		✓	✓					
Is the material related and appropriate to the purpose?		✓	✓					
Is the material objective and unbiased?	✓	✓	✓		✓		✓	✓
Does the site address any areas of uncertainty?		✓		✓				
Does the site offer a disclaimer for the use of its information?					✓			
Is information fully explained, clear, and concise?	✓	✓						✓
Is the information relevant, accurate and current?				✓	✓	✓	✓	✓
Does the site offer suggestions for discussing medical concerns?		✓						
Does the site offer and explain choices and options for a patient?		✓	✓					
Does the site provide anecdotes from others' experiences?					✓			
Does the site display number of viewers, and times the site it cited?								
Are there grammar and spelling errors?					✓			✓

Table 2 (continued)

	HONCode[a]	DISCERN[b]	QUICK[c]	WebWatch[d]	Judge Project[e]	eEurope2002[f]	IQ Tool[g]	Children's Partnership[h]
Is the site well organized and easily navigated?							✓	✓
Are links appropriate, well organized, relevant, and current?					✓		✓	
Is the site easy to view and access?					✓	✓		✓
Does the site use appropriate language?								✓
Is the site available in other languages?								✓
Is the site accessible to individuals with disabilities?					✓			✓
Is the site provided at a low cost or free?								✓
Does the site appeal to an underserved community?								✓
Does the site target a specific cultural group or reflect diversity?								✓
Does the site give local information and allow audience contributions?								✓

[a] www.hon.ch/HONcode/Conduct.html
[b] www.discern.org.uk/discern_instrument.php
[c] www.quick.org.uk/
[d] www.consumerwebwatch.org/consumer-reports-webwatch-guidelines.cfm
[e] www.judgehealth.org.uk/how_to_judge.htm
[f] www.jmir.org/2002/3/e15/
[g] www.hitiweb.mitretek.org/iq/default.asp
[h] www.contentbank.org/AM/Template.cfm?Section=Home3&Template=/CM/ContentDisplay.cfm&ContentID=4679

content. WebWatch, designed by Consumer's Report is similar: it is both easy to use, but not specifically tuned to the content of health-related Web sites. For a thorough, though time-consuming evaluating, the Children's Partnership guidelines may be preferred. In addition to evaluating the quality of a Web site, Children's Partnership also include criteria for low barrier Web sites, which are considered more easily accessible for individuals. These accessibility requirements focus on meeting needs of individuals with disability and of different cultures and geographic regions. Though they have their benefits, the costs of the QUICK tool, WebWatch, and Children's Partnerships make them less likely to be helpful in clinical settings.

Putting the Process in Action: A Sample Evaluation of the NSGC Web site

To provide an idea of what is necessary in evaluating Web sites, an assessment was made on a single page of the NSGC Web site, which examines family history (http://www.nsgc.org/consumer/familytree/index.cfm). The page is classified under "Consumer Info", suggesting it is targeted at a general audience, not only genetic counselors. The page discusses how to collect and organize health-related family history.

Readability of "Family History" on www.NSGC.org

The readability of the text was assessed using the Flesch–Kincaid Grade Level (FKGL), the Flesch Reading Ease (FRE), and the SMOG readability formulas. The first two formulas were selected based on their wider availability: they could be calculated using Microsoft Word, Readability Calculation, and the selected online tool (www.online-utility.org/english/readability_test_and_improve.jsp). SMOG was selected because it uniquely calculates the reading level necessary to understand the complete text, rather than just most of the text, as do other readability formulas; it was available through Readability Calculation and the online tool.

First, the text was copied and pasted into a Microsoft Word document and assessed based on no editing, except for the removal of the "Download Print Friendly PDF" button. Microsoft Word produced a FKGL score of 9.3 and a FRE score of 56.2, based on 838 words and 44 sentences. Readability Calculations gave the text a FKGL score of 13.4, a FRE score of 48, and a SMOG score of 14.9, based on 856 words and 31 sentences. Finally, the online tool produced a FKGL score of 10.48, FRE score of 49.22, and a SMOG score of 12.46, based on 871 words and 53 sentences. As can be seen by the diversity of the readability scores, as well as the word and sentence counts, the

programs approach the readability assessment using different assumptions, such as definition of a word, sentence, and paragraph and treatment of hyphenated words, lists or bulleted points, and punctuation (e.g., apostrophes, parentheses, quotes). Also, as mentioned before, the example demonstrates how Microsoft Word limits Flesch–Kincaid Grade Level scores to 12th grade while Readability Calculations did not (Hochhauser 2002).

Next, the text was edited: the last two sentences, which included Web site addresses, were removed; headers were deleted; lists were written as sentences; and punctuation, such as dashes, quotes, parentheses, slashes, and apostrophes, were removed. Parentheses were either replaced by commas or rewritten as sentences, based upon the fragment within the parentheses. Additionally, the series of three periods (i.e., ...) in the last sentence of the first paragraph was removed. As a result of the editing, all three measures assessed the text based on 757 words and 44 sentences. Microsoft Word produced a FKGL score of 8.8 and a FRE score of 59.9. Readability Calculations computed a FKGL score of 9.3, a FRE score of 59, and a SMOG score of 12.2. The online tool produced a FKGL score of 10.56, a FRE score of 50.01, and a SMOG score of 12.34.

Though the scores produced after editing were more similar to each other than the scores produced before editing, the three measures do still have some differences, due to the differing assumptions each program makes, which were not disclosed by either Microsoft Word or the online tool. Taken together, these assessments suggest that the "Family History" page of the NSGC Web site is above the average reading level of the 8th grade, and may not reach the widest audience possible. The editing did not appear to inflate the readability; in fact the scores, especially those produced by Readability Calculations, would indicate editing made the text more readable.

Quality of "Family History" on www.NSGC.org

To assess quality, Health on the Net (HON) Code and DISCERN were applied to the Family History Web page. The former was chosen because it provides accreditation, allowing a Web site who complies with the criteria to display the HONCode logo. The latter was chosen to demonstrate potential problems with fit between the Web site's content and the quality guideline's criteria; DISCERN is targeted at content discussing treatment options. The HONCode employs eight criteria: (1) authority (indication of author and his/her qualifications), (2) complementarity (support, not replacement, of the doctor–patient relationship), (3) privacy (respectful treatment of personal data submitted to the site by the visitor), (4) attribution (citations for sources of published information, date and medical and health pages), (5) justifiability (support for claims relating to benefits and performance), (6) transparency (accessible presentation and accurate email contact provided), (7) financial disclosure (identification of funding sources), and (8) advertising policy (clearly distinguished advertising from editorial content). The NSGC "Family History" page meets five of these criteria (i.e., complementarity, privacy, transparency, financial disclosure, and advertising policy). While the page does not indicate the qualifications of authors (authoritative), it is produced by a reputable organization, which does have authority on the topic. The page also does not cite its sources (attribution), though it does provide external links to sources that may be used to verify information. Finally, the page does not support claims related to benefits or performance. Although for this criterion, it does not appear necessary to do so for the discussion of how to collect a family history.

DISCERN employs 15 criteria, divided into two general sections: reliability and quality of information on treatment choices. Since the NSGC "Family History" page does not address treatment, the second section is not applicable in evaluating the quality of the "Family History" page. The first section, reliability, focuses on eight questions: (1) are the aims clear, (2) are the aims achieved, (3) is the content relevant, (4) is it clear what sources were used, (5) is it clear when the information used or reported was published, (6) is the content balanced and unbiased, (7) does it provide details of additional support and information, and (8) does it refer to areas of uncertainty. These criteria are rated on a scale ranging from 1, being does not meet the criteria, to 5, being completely meets the criteria. The ratings for each criterion are provided in parentheses in the explanation below. The NSGC "Family History" page does not clearly mention its aims, but implies them in the headings (3), and it does achieve its aims (5). It provides relevant content (5). The page does not make its sources clear, but there are some external links to sources that may be used to verify information (3). While there is a copyright date range for the page, the page does not clearly state when the publication was produced (4). The page appears balanced and unbiased (5), and it provides details for additional sources (5). The final criterion for the first section, addresses area of uncertainty, does not appear to apply to the "Family History" page. By averaging the applicable scores, it appears the page scores about a 4.25, suggesting that page has potentially important, but not serious shortcomings.

Putting Readability and Quality Together

The strength of the "Family History" Web site on www.NSGC.org lies in its quality. The readability may be higher than that of the average population. Thus, the Web site may be less appropriate to recommend to individuals with less

education, who have a lower reading level, and/or who have no familiarity with family history collection.

Discussion

With greater numbers of people turning to the Internet for health information, including genetic-related material, genetic counselors and other health care providers have the opportunity, and arguably the responsibility, to aid patients on their search. To provide valuable feedback and direction, genetic counselors and other health care providers should be able to assess the readability and quality of health information on genetics-related and general health-related Web sites. We have provided a variety of methods and tools to assess readability and quality of information provided on genetics-related Web sites. Additionally, we have provided an example of the process of evaluating a Web site's readability and quality. While the process outlined here can be valuable, it is necessary to understand the limitations of readability and quality assessments.

Limitation of Readability Assessments

Because the readability formulas offer different approaches to assessing readability and the tools, such as Microsoft Word and Readability Calculations, make different assumptions in their assessments, it is possible and common to get variance in the scores when evaluating the same text using different formulas. For instance, because the SMOG Index calculates readability based on 100% understanding of the text, the formula will often produce higher scores than other formulas. Additionally, tools may assess a text with different scores, even when using the same formula. As seen in the example, not only was there a range in scores based on using different formulas, but there was also a range for the specific scores (e.g., Flesch Reading Ease) from the three tools. Readability formulas correlate well with each other (Friedman and Hoffman-Goetz 2006), and it may be acceptable to calculate readability using only one formula. Using multiple formulas, however, will provide a broader understanding of the Web site's reading level. Additionally, no readability formula or tool provides a definitive measure of readability level; formulas are best employed as general guidelines. Knowing how the readability was assessed, by understanding a formula's criteria and the program's assumptions, better prepares individuals to interpret readability scores. Furthermore, when designing a Web site, readability formulas should not direct the writing (e.g., Redish and Selzer 1985). For instance, while writing using shorter sentences can improve the readability scores based on several formulas, shorter sentences do not always equal clearer sentences (Redish and Selzer 1985).

Readability formulas do not take into consideration format of the text, such as organization and visual effects. In a review of Web site evaluation tools and articles, the second most frequently mentioned category of evaluative criteria was design and aesthetics, including issues of layout, interactivity, presentation, and graphics; 13% of the reviewed evaluation tools and articles expected Web sites to address such characteristics (Kim et al. 1999). Format factors can enhance the readability of text (Doak et al. 1996), and these are difficult to evaluate with existing readability formulas or quality indicators. For instance, a table can make a paragraph burdened by statistics more understandable, and lists may make text easier to read, but readability formulas usually account only for sentences.

Readability formulas are not tailored specifically for medical content. Short genetics terms, such as "codon," may be judged as easy to read, simply because it has few letters and few syllables; in actuality, the average individual unfamiliar with genetics terminology would struggle to understand the text. Medical terms may be defined within the text (a technique known as "arching"), which will produce longer sentences, and subsequently lower readability based on many formulas. However, these definitions are more likely to enhance readability of the text, by offering explanation and clarification. Overall, when deciding if a Web site is appropriate for given individuals, it is necessary to consider their health literacy, or knowledge that they already possess about the topic.

Of course, it may be difficult in most situations to assess the specific healthy literacy, or even general reading level, of individual consultants or patients. Numerous tools are available to assess literacy skills in health-care domains (see Davis et al. 1998 for a review). However, when using such assessments is not possible, education level is the quickest way to assess reading level, since this is how readability scores are interpreted; education level is already commonly assessed by many genetic counselors and other health-care providers. When considering Web site design, Web sites written at the reading level of the general population have better opportunity to pertain to a diverse audience.

Limitation of Quality Assessments

When assessing quality, it is important to remember that criteria such as credibility and currency are used as indirect indications of accuracy. There is no guarantee that these measures reflect actual accuracy of the information. One assessment found that features of Web site credibility (e.g., indicating the source, currency of the site) are weakly to moderately correlated with accuracy of information (Kunst et al. 2002); however, the review did not target any genetics-related Web sites. An assessment of breast cancer Web sites found that lower quality Web sites, as determined by a lack

of authorship, references, currency, or disclosure, made more inaccurate statements than higher quality Web sites, although inaccurate Web sites were a small minority overall (12%; Meric et al. 2002). Overall, high quality, as assessed based on tools such as HONcode and DISCERN, is useful in determining accuracy of information, but is not a conclusive measure of accuracy. Additionally, even when using the quality assessment tools, it is necessary to make subjective judgments. For instance, when assessing partial achievement of the DISCERN criteria, there were no clear explanations of what content achieved a 2, 3, or 4 on the scale.

Finally, for any given Web site, some quality guidelines may be better suited than others. As was seen in the example, the DISCERN tool may not have been the most appropriate tool when judging the NSGC "Family History" Web page. Thus, when evaluating quality of a Web site, one must find a tool that is appropriate for that content matter. Finding the appropriate tool, however, may be a difficult task. With perhaps the exception of the DISCERN, which was developed for information about treatment choices, and the DISCERN genetics tool, which was developed for information about genetic screening and testing, the guidelines themselves do not provide specifications for what type of Web site they are most appropriate. Recently researchers have endeavored to develop quality guidelines oriented towards specific diseases, including Alzheimer's (Bath and Bouchier 2003), diabetes (Seidman et al. 2003), and multiple sclerosis (Harland and Bath 2007). Overall, the HONCode guidelines are highly recommended as they are well established and commonly used in evaluating Web sites' quality.

Conclusions

With more and more people turning to the Internet as their primary source of genetics information, and other general health concerns, genetic counselors and other health care providers will be increasingly called upon to assist patients and the general public in their search. To benefit most from genetics and other health-related Web sites, Internet users need Web sites that are at their reading level and contain high quality material. Without guidance from counselors and health care providers who have evaluated these components, patients may turn to Web sites that they do not understand or to Web sites that offer inaccurate or inappropriate information. Armed with these weaker sources of information, patients will be unprepared to make well-informed decisions in regards to their health, genetically-related or otherwise. While the tools and procedures provided here may have limitations and may not offer definitive measures of readability or quality, they certainly can better prepare genetics counselors and other health care providers to offer guidance and direction to health information consumers.

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