Assessment of Internet-based Information on Statin Therapy

Short head: Assessment of Information on Statins

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ABSTRACT

Aim

The use of statin therapy is deemed to be controversial by mainstream media. Patients increasingly source medical information from the internet and the use of statins is no exception. This study aims to determine the quality and educational content of statin-focused information on the internet and YouTube.

Methods and Results

“Statin” was searched on Google, Yahoo!, Bing and YouTube. The first 50 results obtained from each search engine and first 20 YouTube videos were screened by two assessors. Websites were assessed using the Flesch Reading Ease (FRE) Score, University of Michigan Consumer Health Website Evaluation Checklist and a customized scoring system evaluating statin-focused content for quality. Videos were scored using the Journal of American Medical Association (JAMA) benchmark criteria, Global Quality Score (GQS), and the customized scoring system.

Websites scored a median FRE score of 57.5 (IQR 52.1-62.3), median Michigan score of 36 (IQR 32-41.5), and median content score was 5 (IQR 3.75-7), Good interobserver agreement was demonstrated (Michigan score ICC=0.968; content scores ICC=0.944). Videos scored a median JAMA score of 2, median GQS score of 2.5 and median content score of 2.5. Good interobserver agreement was demonstrated (JAMA ICC=0.746; GQS ICC=0.874; content scores ICC=0.946).

Conclusions

Quality and readability of statin-focused online information is poor. Healthcare professionals should be aware of the limitations of the current available sources and design online resources that are accurate and patient friendly.
1. **INTRODUCTION**

Patients desire background knowledge of health-related information to aid their healthcare decision making process (1,2). Prior to the internet, many patients relied on information from trusted healthcare providers or mass media sources (3). In modern society, the Internet serves as a fundamental platform for patients to engage in various health-related activities, including obtaining information about medical conditions and treatment options (4).

Seventy seven percent of health-related online searches are initiated through a search engine like Google, Yahoo! or Bing (5). Results generated from these common search engines often lead on to popular video-streaming sites such as YouTube, which has approximately 30 million health-related videos shared (6,7). However, the validity of the health information available on the internet cannot be guaranteed; any individual, regardless of qualifications, can publish information and upload content on YouTube.

Elevated low-density lipoprotein cholesterol (LDL-C) is a major risk factor for cardiovascular disease (9,10). Lowering of LDL-C is a proven strategy to reduce the risk of major adverse cardiovascular events (10). Statins are the first line lipid-lowering therapy. They competitively inhibit hydroxymethylglutaryl-CoA reductase lowering LDL-C by increasing its hepatic uptake from the circulation (11), and are usually well-tolerated with myopathy, rhabdomyolysis, hepatotoxicity being the most common adverse reactions. Each 1.0 mmol/L reduction in LDL-C reduces the annual rate of myocardial infarcts (MI) and ischaemic strokes by a fifth (10).

In 2016, the mainstream media in the UK led a period of public debate questioning the safety and efficacy of statins (12) which resulted in significant controversy and misinformation. As a result, an estimated 200,000 people stopped their statin treatment within a 6-month period (13). This example demonstrates how easily the public can be led by poor medical information to
reject evidence-based medicine and the recommendations of medical professionals, resulting in detrimental effects to public health (14).

Although statins continue to be widely prescribed medications with a strong evidence-base supporting their use in the primary and secondary prevention of cardiovascular disease, there are continuing issues with medication adherence (15). This study aims to examine the quality and educational content of available patient information about statin therapy from both the internet and YouTube videos.
2. METHODS

2.1 Website Identification and Assessment

The three most popular U.K. search engines by market share, Google, Yahoo!, and Bing were used to perform a search in December 2021 using the term “statin” from an Internet Protocol address in Leeds. The first 50 results returned by each of the three search engines was recorded.

Each website was evaluated for relevance to patients offered statin therapy. Websites duplicated on more than one search engine were only assessed once. Websites were included for analysis if they contained information about statin therapy that patients could feasibly use as a source of disease-specific information, even if they were not designed with patients in mind. Websites were excluded as per criteria in Figure 1. Assessment was carried out independently by two of the authors (J.K. and F.S.) with experience in statin therapy for quality and readability as directed by the instructions supplied with the tools used. Any divergence was solved by reconsideration and consensus.

The type of organization producing each website (commercial company; healthcare provider; academic institution; charitable organization; layperson; government; or news outlet) was recorded.

The Flesche Kincaid Reading Ease (FRE) score was used to measure readability (16). The scores for each website were calculated automatically by entering the universal resource locators directly into https://www.webfx.com/tools/read-able/.

Website quality was assessed objectively using the University of Michigan Consumer Health Website Evaluation Checklist (17). A subjective assessment was also made for each website.
using five quality markers that were deemed of particular relevance by all members of the research team (Table 1). A score was given for each quality marker ranging from 0-2; where 0= quality marker not mentioned, 1= mentioned but no details provided, 2= mentioned with details.

2.2 Video Identification and Assessment

Videos were identified on YouTube (https://www.youtube.com/) in December 2021 from an IP address in Leeds using the term ‘statin’. The first 20 videos retrieved were recorded for further evaluation.

Videos were excluded from the assessment as per criteria in Figure 1. All videos were assessed by two of the authors (J.K. and F.S.) independently. Any divergence was solved by reconsideration and consensus.

Video characteristics including– (i) title, (ii) video duration, (iii) number of views, (iv) number of likes, and (v) type of publisher (commercial company; healthcare provider; independent academic channels, charitable organization; doctor from independent channels; other healthcare workers from independent channels, government; or news outlet) - were recorded.

Each video was scored against the Journal of the American Medical Association (JAMA) benchmark criteria (18). Overall educational quality of video content was assessed using the Global Quality Score (GQS) (19). Content specific assessment was carried out using another subjective scoring system devised by the authors - the score was divided into 6 domains to assess breadth and depth of video content: (i) Role of LDL-C / cholesterol in atherosclerosis, (ii) link between LDL-C and outcomes, (iii) lifestyle management for primary and secondary risk, (iv) guidelines, (v) treat to target and (vi) side effects and management of. Inclusion of each element scored 1 point.
2.3 Statistical Analysis

All statistical analyses were conducted using SPSS v.26.0. P-values were expressed to nearest 2 decimals and a p-value of <0.05 was deemed statistically significant. Summed analysis scores are shown as median and interquartile range (IQR). Categorical variables are presented as percentage frequencies and numbers.

For all the websites, the correlation between the Michigan and FRE scores was measured using Spearman’s rank correlation coefficient. Kruskal-Wallis test was carried out to determine whether FRE or Michigan scores differed with the level of recognition of each of the five quality markers. Mean Michigan scores and the higher score out of the two content scores were used for the calculation.

The interobserver coefficient correlation (ICC) for the Michigan and the GQS score was undertaken. For all YouTube videos analyzed, the JAMA, GQS, and content score were correlated with the view counts and like counts using Spearman’s rank correlation coefficient.
3. RESULTS

3.1 Website Assessment

Of the 150 websites retrieved from the search, there were 91 unique sites with 38 relevant sites for assessment (Figure 1).

Four websites (10.5%) were published by an independent commercial company (e.g. SAGA.co.uk); 7 (18.4%) by a healthcare provider (e.g. Mayo Clinic, John Hopkins Medicine); 3 (7.9%) by an academic institution (e.g. Nuffield Department of Population Health), 9 (23.7%) by a charitable organization (e.g. British Heart Foundation, Heart UK), 12 (31.6%) by a government agency (e.g. NHS, GOV.UK), and 3 (7.9%) by a news outlet (e.g. Medical News Today).

3.1.1 Website readability and quality

One website (https://www.drugs.com/atorvastatin.html) was not compatible with the scoring website used. Out of the remaining 37 websites, the median FRE score was 57.5 (IQR 52.1-62.3, Range 38.3-87.5) (Figure 2). This suggests that the average website is considered difficult to read and would be understood by someone with an education level of a 10th to 12th grade student. Overall, the majority of the assessed websites (65%, n=24) were classed as difficult in the FRE scoring system.

Most websites were rated as ‘weak’ in the Michigan scoring system with none of them scoring in the ‘good’, or ‘excellent’ range. The median Michigan score was 36 (IQR 32-41.5) (Figure 2). Interobserver agreement was good with an intraclass correlation coefficient of 0.968 (95% CI 0.939-0.983, P<0.001).

There was a weak, negative correlation between FRE and Michigan scores which was statistically significant ($r_s = -0.230, p = 0.049$).
3.1.2 Content specific assessment

Median score for content specific assessment was 5 (IQR 3.5-6.5). Interobserver agreement was once again good with an intraclass correlation coefficient of 0.944 (95% CI 0.886-0.971, P<0.001). Differences in FRE and Michigan score for the five content markers are shown (Table 1).

Fifty-five percent of websites (n=21) discussed in detail the link between LDL-C concentrations and cardiovascular outcomes in secondary prevention; 45% (n=17) in little detail; and 0 did not mention this point. No significant differences in FRE (p=0.26) or Michigan score (p=0.19) were noted between websites with different levels of detail provided.

Eleven percent (n=4) discussed in detail differences in management of lipid-lowering therapy between primary and secondary prevention; 42% (n=16) in little detail; and 47% (n=18) did not mention this point. No significant differences in FRE (p=0.429) or Michigan score (p=0.959) were noted between websites with different levels of detail provided.

Eight percent (n=3) discussed in detail triggers to escalate statin therapy, movement from single therapy to combined therapy and the need for monitoring; 34% (n=13) in little detail; and 58% (n=22) did not mention this point. Significant higher Michigan scores were seen in websites with more detail provided (p=0.030). No significant differences were seen for FRE scores (p=0.770).

Sixty-six percent (n=25) discussed in detail side effects and strategies to manage these; 34% (n=13) in little detail; and 0 did not mention this point. Significantly higher Michigan scores were seen in those websites with most detail provided (p=0.015). No significant differences were seen for FRE scores (p=0.886).
Forty-two percent (n=16) discussed in detail lifestyle for risk prevention; 37% (n=14) in little
detail; and 21% (n=8) did not mention this point. Significantly higher FRE scores seen in those
websites with most detail provided (p=0.043). No significant differences were seen for Michigan
scores (p=0.302).

3.2 Video Assessment

Of the first 20 YouTube hits, 9 videos were excluded and 11 relevant videos were assessed
(Figure 1).

Six (54.5%) videos were published by a healthcare provider, 2 videos (18.2%) by an
independent academic channel, 1 video (9.1%) by a charitable organization, and 2 videos
(18.2%) by a doctors running an independent channel.

Median number of days since publication was 1595 (IQR 991-1768), video duration was
03:48min (IQR 02:53-08:56), number of views was 57823 (IQR 15865-477392) and number of
likes was 287 (IQR 107-4332).

3.2.1 Video Reliability and Educational Content

Median JAMA score was 2 (IQR 2-2; ICC 0.746 [95% CI 0.139-0.930, p=0.011]). The median
GQS score was 2.5 (IQR 2-3.75; ICC 0.874 [95% CI -0.011-0.973, p<0.001]). The evaluation of
content score was 2.5 (IQR 1.25–3.75; ICC 0.946 [95% CI 0.808-0.985, p<0.001]).

The JAMA, GQS, and content score were correlated with the number of days since publication,
number of views and number of likes. The only significant correlation seen was that between the
content specific score and the number of days since publication \( r_s = 0.486, p = 0.022 \).
4. **DISCUSSION**

Increasingly, Internet users are searching for health-related information to acquire answers to questions about symptoms, diagnoses and treatment. Social distancing, lockdowns and isolation policies worldwide due to the Coronavirus Disease 2019 (COVID-19) also resulted in reduced access to in-person health care and increased reliance on online information (20). The rising popularity of seeking Web-based information is likely due to a number of reasons – coverage of vast information, being able to share experiences and form support groups, and predominantly the convenience, ease, and speed of access at any time and from any location (21). However, the internet is unregulated, and therefore the quality, and trustworthiness of information remains a concern to both healthcare professionals and patients. Finding credible health information has been perceived as challenging even for younger patients, and even more so for patients with lower educational attainment (21).

This is the first study to comprehensively assess the quality of online information for statin therapy. The majority of the websites and videos were excluded, meaning that it can be challenging to identify suitable sources of information in the first place. We found that the quality of web-based statin information was poor with generally weak Michigan scores and the readability of websites was difficult. Median FRE score was 57.5 (difficult) compared to the U.K population standard reading level of 60-70 (average) (22). This suggests that a large proportion of the U.K population will not be able to fully comprehend the greater part of available information, regardless of the quality of content even if they find adequate information online. The general quality of the video available on YouTube related to statin therapy was also poor.

Our findings are consistent with published literature looking at quality of online resources in both the field of cardiology and vascular surgery – specialties where statins are commonly prescribed as part of cardiovascular risk prevention. Bonner et al. (23) concluded that publicly available
cardiovascular prevention information are not suitable for low literacy populations. Bailey et al. (24) analyzed quality and readability of online patient information relating to abdominal aortic aneurysms (AAA) whilst Dar et al. (25) and Treffalls et al. (26) looked at quality of patient information relating to peripheral arterial disease and all concluded that educational quality and readability of information both in written and video form on the internet is low. Overall, our findings corroborate such findings and reinforce that the available information on the internet focused on cardiovascular related matters are generally poorly written and unreliable.

4.1 The Use of Statins in Primary and Secondary Prevention of Atherosclerotic Events

Adherence to secondary prevention medications including statins have been shown to improve cardiovascular outcomes, decrease overall mortality and decrease readmission in patients presenting with acute MI (27). Appropriate statin therapy with an associated reduction in LDL-C levels also reduces the risk of major adverse cardiovascular events (MACE) in the longer term (10). However, recommended doses vary dependent on the indication. U.K National Institute for Health and Care Excellence (NICE) recommends atorvastatin 20mg for primary prevention compared to atorvastatin 80mg for secondary prevention (28). In our study, 47% of websites did not discuss the difference between primary and secondary prevention at all. This finding is concerning because adherence to statin medication is often lower in primary prevention than secondary prevention (29), and a clear explanation of the rationale and difference between both might help to improve adherence and patient outcomes.

The dose-dependent reduction in cardiovascular disease with LDL-C lowering is well-recognized. The annual rate of MI and ischaemic strokes was reduced by just over a fifth for each 1.0 mmol/L reduction in LDL-C with a standard statin regimen (10), and the ESC/EAS Dyslipidemia guidelines (30) therefore recommends an LDL-C level <1.8mmol/L or a 50% relative reduction in LDL-C with escalation of lipid lowering monotherapy if targets are not met.
Whilst 55% of websites did discuss the link between LDL-C concentration and cardiovascular outcomes in significant details, it was noted that most websites (58%) did not discuss the need for LDL-C monitoring and subsequent escalation of lipid-lowering therapy as required. This is no doubt an area for improvement, as goal setting is a recognized strategy to promote health behavior changes and improve adherence to treatment plans (31).

Herber et al. (32) found that vast majority of patients consider side effects of medications as important information that should be included in patient information sources, and it is recommended that clinicians should educate patients on side effects when a patient is prescribed a statin (11). It is therefore commendable that all websites covered information on side effects, of which 66% discussed these side effects in significant detail. However, it is also suggested that current patient information sources often convey side effects in a way that triggers strong emotions of fear and anxiety which may be associated with a decrease in medication adherence. Patient advisory groups should be utilized to produce information about possible side effects in a language of risk that can provide vital information necessary yet be perceived as less frightening to avoid patients discontinuing prescribed medications.

American, British and European guidelines all present evidence of the value of healthy diets and of physical activity for both primary and secondary prevention of cardiovascular disease, and studies have shown that much of the recent decline in cardiovascular mortality worldwide including the UK is attributable to changes in risk factors independent of prescribed medication (33). Less than half (42%) of the websites discuss this point in significant detail and 21% did not mention the link at all. This highlights another area of improvement to help improve outcomes.
4.2 Limitations

Our search reflects a snapshot in time from a single researcher in a single location. Due to the personalized nature of search engines, it is possible for different users to get varying results depending on location, personalization and algorithm variations. The fluid nature of the internet also means that changes in content are not captured. However, our chosen number of 50 websites provides reassurance that this study has captured the top ‘hits’ that would come up for multiple users.

Despite being validated and universally utilized, all scoring systems used have their own limitations. The FRE does not take into account pictures and tables, document factors (layout, colour and font), person factors (health literacy, motivation, anxiety levels), and style of writing (cultural sensitivity) - which can impact reading levels (34). On the other hand, the subjective nature of the Michigan score, JAMA, GQS and content scores may introduce variability in scoring and therefore bias. However, the effects of this are likely to be minimal in our analysis, as significant, high levels of inter-rater consistency were demonstrated across all scoring systems. Although the use of customized scoring systems complements overall assessment of the data, the lack of validation might introduce issues with reproducibility.

It was also noted that the median number of days since publication for YouTube videos was 1595, (IQR 991-1768, Range 244-2596). This suggests that YouTube might suggest older videos over newer videos. Therefore, information content from suggested videos is likely outdated which could explain the reduced quality of information.
4.3 Recommendations for development of online sources of patient information

Current websites and YouTube videos are still limited in the quality and accuracy of information despite advances in the internet. Areas which websites commonly scored poorly in were analyzed and the following suggestions were derived.

To improve the readability of websites, websites should avoid medical terminology, which can help to reduce FRE grade level by 0.3 on average (35). This will ensure that information is accessible to patients of all socio-economic and education backgrounds.

To improve the quality of patient information available on the websites, it is suggested that website providers references that are accurate, and contain credible sources. Websites should be reviewed regularly and include a last review date to ensure the presence of updated or current information. Although there is no consensus regarding the ideal frequency of review, NHS.uk aims to review content at least every 3 years, and all ratings and reviews about events must be within the past 2 years. These two suggestions are in-keeping with attributes that health care consumers consider when assessing the accuracy of information (36). Websites should also avoid advertisements where possible, and if required, should be clearly distinct and non-animated. Most importantly, involving potential patients through the formation of an advisory group at early stages of the production process will highlight areas deemed important to patients. This will ensure quality, relevance, and success in the testing later on (37).
5. **CONCLUSION**

Statins are widely used in both primary care and secondary care settings. All healthcare professionals should be aware that the quality of patient information available on the internet is highly variable and may not be evidence-based. Healthcare professionals should research websites so that they can guide patients towards reliable websites set at an appropriate level to that individual to ensure that patients are making informed healthcare decisions, and institutions should take the initiative to develop online educational resources that are guided by target groups, and are trusted, reliable, and comprehensible.

**AUTHORS’ CONTRIBUTIONS**

**Jing Yi Kwan:** Formal analysis (equal); Visualization (equal); Writing – Original draft preparation (equal), Writing – Review and editing (lead). **Fabio Stocco:** Formal analysis (equal); Visualization (equal); Writing – Original draft preparation (equal); Writing – Review and editing (supporting). **Marc Bailey:** Conceptualization (equal); Supervision (equal); Methodology (Equal); Writing – Review and editing (supporting). **Patrick Coughlin:** Conceptualization (equal); Supervision (equal); Methodology (equal); Writing – Review and editing (supporting). **Julian Scott:** Conceptualization (equal); Supervision (equal); Methodology (equal).

**DATA AVAILABILITY STATEMENT**

The data underlying this article will be shared on reasonable request to the corresponding author.
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LEGENDS

Figure 1. Flowchart showing inclusion and exclusion of websites and YouTube Videos.

Figure 2. Distributions of Michigan scores and Flesch-Kincaid Reading Ease scores. The middle horizontal line indicates the median; the top and bottom lines mark the 75th and 25th percentiles, respectively.

Table 1: Comparison of the Flesch Reading Ease (FRE) and Michigan scores for five quality markers. P Value derived using Kruskal Wallis analysis of variance and rounded to nearest 2 decimal places.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

STATEMENTS OF CONSENT AND ETHICAL APPROVAL

Ethics approval was not required for this study as it utilizes information freely available in the public domain. No humans or animals were involved in this study.
Figure 1

Total excluded [n=53]
- Unusable information (e.g., providing only a plain definition or discussing another disease) [n=8]
- Journal articles (both paid and open access articles, patient pages by medical journals or patient-information journals articles were included) [n=8]
- Clinical guidelines [n=27]
- Inaccessible (e.g., a dead link or requiring download of a portable document format (PDF) to access the information) [n=2]
- Irrelevant (e.g., not related to the search terms) [n=8]
- Websites not in English [n=0]

Total excluded [n=9]
- Lack of relevance for patients (e.g., a focus on examination findings and teaching for junior doctors or molecular mechanisms of disease) [n=6]
- Did not focus directly on the search topic [n=1]
- Inaccessible (e.g., requiring sign in to watch the video) [n=1]
- Irrelevant (e.g., the video content does not focus on statin therapy at all) [n=2]
Figure 2
123x87 mm (x DPI)
Graphical Abstract

Assessment of internet-based information on statin therapy

- Results from each search engine
- Included websites
- Search term: “Statin”
- Initial YouTube videos
- Included videos

Flesch Reading Ease Readability Score
- Median score (IQR): 57.5 (52.1–62.3)
- Difficult to read
- Required education level of 10th-12th grade

Journal of American Medical Association Benchmark Criteria
- Median score (IQR): 2 (2–2)
- Poor reliability and accuracy

University of Michigan Consumer Health Website Evaluation Checklist
- Median score (IQR): 36 (32–41.5)
- Weak quality

Global Quality Score (GQS)
- Median score (IQR): 2.5 (2–3.75)
- Low-medium quality

Customised scoring system evaluating statin-focused content
- Poor information content with limited relevance; breadth and depth within both websites and videos

Quality and readability of statin-focused online information is poor

Healthcare professionals should research websites to guide patients towards reliable sources

Institutions should develop online educational resources that are guided by target groups

Graphical Abstract
165x120 mm (x DPI)
<table>
<thead>
<tr>
<th>Quality Marker</th>
<th>Median FRE/ Michigan score for mentioning of each quality marker (IQR)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2; mentioned with good detail</td>
<td>1; mentioned with little detail</td>
</tr>
<tr>
<td>(1) recognition of the link between LDL-C concentration and cardiovascular outcomes in secondary prevention</td>
<td>FRE</td>
<td>53.7 (52.1-60.2)</td>
</tr>
<tr>
<td></td>
<td>Michigan</td>
<td>37.5 (34-45)</td>
</tr>
<tr>
<td>(2) recognition of the presence of guidelines for clinical practice on the management of lipid-lowering therapy and specifically the difference between primary and secondary prevention</td>
<td>FRE</td>
<td>54.35 (48.88-56.6)</td>
</tr>
<tr>
<td></td>
<td>Michigan</td>
<td>36.75 (35.25-38.75)</td>
</tr>
<tr>
<td>(3) recognition for the triggers to escalate statin therapy and movement from single therapy to combined therapy AND the need for monitoring</td>
<td>FRE</td>
<td>61.7 (56.9-63.65)</td>
</tr>
<tr>
<td></td>
<td>Michigan</td>
<td>48.5 (45-52.75)</td>
</tr>
<tr>
<td>(4) recognition of the effect of side effects AND strategies to manage these</td>
<td>FRE</td>
<td>56.9 (51.9-62.68)</td>
</tr>
<tr>
<td></td>
<td>Michigan</td>
<td>39 (33.5-46)</td>
</tr>
<tr>
<td>(5) recognition of the role of other lifestyle factors for primary / secondary risk prevention</td>
<td>FRE</td>
<td>59.8 (55.65-64.88)</td>
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<tr>
<td></td>
<td>Michigan</td>
<td>35 (33.13-38.25)</td>
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