Use of Google as a Tool to Aid Diagnosis by Optometry Students

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Abstract

**Background:** Previous work has shown that medical problems can be diagnosed by practitioners using Google. The aim of this study was to determine whether optometry students would benefit from using Google when diagnosing eye diseases.

**Methods:** Participants were given symptoms and signs and instructed to list three key words and use them to search Aston University e-Library and Google UK.

**Results:** Aston University e-Library only search resulted in correct diagnosis in 16 of 60 simulated cases. Aston e-Library plus Google search resulted in correct diagnosis in 31 of 60 simulated cases.

**Conclusion:** Google is a useful aid to help optometry students improve their success rate when diagnosing eye conditions.

**Key Words:** Aston e-Library, diagnosis, Google, ocular conditions, optometry students

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Introduction

Recent reports in the literature indicate that medical students and young and experienced doctors can be assisted in reaching the correct diagnosis for uncommon medical conditions using the Google search engine. Greenwald reported a single case study of correct diagnosis of a condition using Google, while Tang and Ng more methodically showed how two experienced medical doctors diagnosed 58% (15/26) of difficult medical cases correctly using carefully selected search terms and Google Web Search. Similarly, Falagas et al. showed that one trainee medical doctor and two final-year medical students increased their total correct diagnoses by almost 10% when using PubMed or Google. Tang and Ng suggested that doctors, especially those in training, should be proficient in the use of web-based search engines.

Twiesselmann, however, reminds us that “Google is not set up as a diagnostic decision support system — although it can be a useful aid to differential diagnosis once a diagnosis has been made” and that “other internet resources exist, for example PubMed and other specialty databases, which might be more specific and useful than Google and of course these sources contain mainly peer-reviewed information.”

Our experience suggests that optometry students frequently use the internet to search for information to aid their learning. The authors wondered whether Google Web Search (from now on referred to as Google) could help optometry students make a correct diagnosis in eye conditions.

The aim of this study was to determine whether conducting internet searches using Google would aid optometry students in the diagnosis of ocular conditions when compared to the Aston University e-Library. Aston University e-Library is a portal to peer-reviewed academic papers in PubMed, Web of Knowledge and other databases. The authors decided to use Google as it had been used in several previous similar studies, because it has been reported that in 2005 Google led more visitors to biomedical journal websites than did other widely used search engines such as Yahoo and PubMed.
Methods

Subjects

Twelve final-year optometry students were recruited after a call for participants was sent by e-mail to all 115 students in the third year of our institution’s three-year optometry degree program. The University’s Ethics Committee approved the study. All subjects signed an informed consent form and all procedures adhered to the tenets of the Declaration of Helsinki.

The second year of the optometry degree program consists of courses in Further Investigative Techniques (contact tonometry and slit lamp biomicroscopy), Contact Lenses (fitting a range of contact lenses and the principles of aftercare), Primary Optometric Examination (subjective refraction techniques and binocular vision evaluation), Ophthalmic Optics (spectacle lens thickness calculations and optics of low vision aids), Vision Science and Research Methods (bottom-up and top-down visual processing and experimental design) and Clinical Practice Development (diagnostic and communication skills). Marks are obtained through continuous assessment of practical and clinical skills throughout the academic year and with an end-of-year written exam. The marks of each module are summed and an average year mark is obtained for each student. Each participant’s end of second year overall percentage mark was determined from University records, and the overall mean and standard deviation (SD) for our 12 subjects was calculated.

The third (final) year of the optometry program consists of five lecture-based courses, one research course and one clinical course. The latter involves working under supervision in public service general optometry, contact lens, pre-screening, pediatric, binocular vision, low vision and dispensing clinics.

All participants had completed 11/24 weeks of the third-year program. This included 33 hours of lectures on anterior and posterior eye conditions and 80 hours of working under supervision in public service general optometry and contact lens clinics. The remaining 13 weeks of education, including lectures on ocular disease, were delivered following the study.

Procedure

One of the authors (FE) selected a convenient sample of five anterior and five posterior eye conditions from an ophthalmology textbook by Kanski and Menon8 and extracted key information on symptoms and signs in order to produce 10 simulated cases. See Figure 1 for examples of extracted signs and symptoms information. See Table 1 for a list of the conditions used in this study. The authors decided not to use cases from the New England Journal of Medicine (NEJM) as used in other previous studies,2,5 as many of the NEJM ophthalmology cases involved rare systemic conditions and included information on imaging and medical procedures and would have been too complex for our subjects.

Participants were given paper copies of the symptoms and signs and instructed to independently list three key words in total after having read the symptoms and signs information. (Figure 1) The information provided to the participants did not contain any images.

Six students were instructed to use their key words to search Aston University e-Library only for a diagnosis of the first group of five simulated cases (all anterior eye conditions) and then to use their key words to search Aston e-Library and Google for the second group of five simulated cases (all anterior eye conditions).

The study took place in a computer lab with two of the authors (FE and HB) present throughout. The students did not know the diagnoses in advance and all had the same education. They were allowed to use search terms individually, all three together or any combination of pairs. This was not monitored or recorded. Google does not suggest a diagnosis, so students were asked to select one diagnosis that best fit the case. All participants had received instruction in the use of Aston e-Library from a librarian experienced in using search tools prior to taking part in the study.

Subjects were instructed not to make a diagnosis based solely on the written description of the simulated case but to use one of the study search strategies as per the study protocol. Although they did have some knowledge of eye diseases, having completed two-thirds of an optometry degree program, and had received 33 hours of lectures, it is unlikely that subjects would have had the

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Anterior Eye Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Keratoglobus</td>
</tr>
<tr>
<td>2</td>
<td>Marginal infiltrates</td>
</tr>
<tr>
<td>3</td>
<td>Dendritic ulcer</td>
</tr>
<tr>
<td>4</td>
<td>Chalazion</td>
</tr>
<tr>
<td>5</td>
<td>Capsular opacification</td>
</tr>
<tr>
<td>6</td>
<td>Commotio retinae</td>
</tr>
<tr>
<td>7</td>
<td>Lattice degeneration</td>
</tr>
<tr>
<td>8</td>
<td>Systemic lupus erythematosus</td>
</tr>
<tr>
<td>9</td>
<td>Central retinal vein occlusion</td>
</tr>
<tr>
<td>10</td>
<td>Coats’ disease</td>
</tr>
</tbody>
</table>

Table 1

Anterior and Posterior Eye Conditions Making up the 10 Cases Evaluated by the 12 Participants
knowledge to make an accurate diagnosis without carrying out an internet search. This is based on our knowledge of the content of the 33 hours of the anterior and posterior courses and our knowledge of the ability of the students who took part. The presence of the two authors in the computer lab would also have encouraged the participants to follow the study protocol.

Key words and diagnoses were recorded by each student on paper and collected at the end of the session. Subjects had their own computer, worked alone contemporaneously and took between two and three hours to complete the task. The time it took to make each diagnosis was not noted. The diagnoses from the participants were then compared with those in the textbook.

In order to determine if academic performance correlated with the students’ ability to choose successful key words to help diagnose the conditions, end of second year overall percentage marks were compared with each of the search methods (Aston e-library plus Google and Aston e-library only) using Pearson’s correlation.

Results

Twelve final-year optometry students with a mean (±SD) end of second year overall percentage mark of 63.34 (±5.32) and a range of 50.12 to 75.00 participated. An average end of second year mark of 50 is poor, while an average of 75 is excellent. The average end of second year mark for our group (63.34) was similar to the average of whole year group (65.00). Each subject considered all 10 cases.

In total, subjects used Aston e-Library only to consider 60 simulated cases and Aston e-Library plus Google to consider 60 simulated cases. Use of Aston-e-library only resulted in a correct diagnosis in 16 out of 60 simulated cases and use of Aston e-Library plus Google led to correct diagnosis in 31 out of 60 simulated cases. The authors also noticed a difference between anterior and posterior conditions. The Aston e-library group did worse than the Aston e-library plus Google group in determining the correct diagnosis for the anterior segment conditions (4 vs. 15 correct diagnoses respectively) while for the posterior segment conditions they were closer (12 vs. 16 correct diagnoses respectively). See Table 2 for a breakdown of the results by participant, condition and search type. No correlation was found between mean end of second year percentage mark and correct diagnosis with Aston e-Library only (r = 0.149, p < 0.05) or Aston e-Library plus Google (r = 0.446, p < 0.05).

Three examples of the symptoms and signs as extracted by FE from Kanski and Menon,7 instructions provided to each participant, and the key words used by the students.

Example 1

Symptoms
Vision is quite poor from induced myopic astigmatism and glare is a significant problem.

Signs
The corneal diameter may be increased and the cornea is thinned throughout. Maximal thinning is usually in the mid-periphery. There may be scattered deep stromal abnormalities but no iron deposition lines present. The anterior chamber is characteristically very deep. Hydrops can occur.

Example 2

Symptoms
Patients complain of photophobia, slight ocular irritation, increased lacrimation, red eye and slight blurring of vision. Recurrences are common. Involvement is usually unilateral.

Signs
The lesion is usually unilateral and typically found in the inferior paralimbal cornea with a 1- to 2-mm clear area of uninvolved cornea between the lesion and the limbus. Lesions may be multiple and grey to white in color. They are typically rounded, approximately 1 mm in diameter and involve the superficial stroma. There is usually a small overlying epithelial defect. The adjacent conjunctiva is usually slightly injected and inflamed. The anterior chamber is usually quieter or with only a trace of cells and flare.

Example 3

Symptoms
Unilateral sudden painless loss of vision.

Signs
Dilated and tortuous veins, flame, dot-and-blot hemorrhages, retinal edema and cotton wool spots. Later signs may include hard exudates, macular edema and neovascularization.

Instruction to Participants
Select three key words from the signs and symptoms provided. You can list paired words, e.g., red eye, and use them in your search as if it were one word. Use all your key words (or paired words) together when you search for the diagnosis.
Discussion

Our aim was to determine if Google could aid optometry students in the diagnosis of eye conditions. The use of Aston e-library plus Google when compared to Aston e-library alone increased the number of correct diagnoses from 16/60 (26.7%) to 31/60 (51.7%). This was independent of previous academic performance. In other words, there was no relationship between academic ability and the ability to make a correct diagnosis using symptoms, signs and either of our search strategies. This is in agreement with other studies where computer skills and choosing appropriate key words were important.2,3

All the students who took part in the study were in year 3 of a 3-year BSc Optometry program with a mean (±SD) end of second year overall percentage mark of 63.34 (±5.32) and a range of 50.12 to 75.00. The overall percentage mark refers to their average mark from all their year-2 modules. These modules cover instrumentation, vision science and research methods, primary eye examination, contact lenses, ophthalmic optics and clinical visual biology. The study was conducted in December, half way through the teaching element of year 3. Year-3 modules include anterior and posterior eye disease topics. We do have some students in the total year group (115) who had a high overall year average (75-80%) and others with a low overall year average (45-50%). Our range (50 to 75%) shows that we had a variety of students with a range of academic ability that reflected the spread in the total year group. Furthermore, the end of year average for the whole year group (115 students) was 65%. These figures are similar to those from other optometry year groups at our university and to those at other UK optometry schools and probably reflects a UK marking style which is likely to be different from that in North America. It is our opinion that the students who volunteered to take part in this study were of a wide academic range and that there is unlikely to be inherent bias in the dataset due to the students who participated.

Our correct diagnosis percentages are lower than Tang and Ng’s result of 58% correct diagnoses2 from 26 cases when using Google. This is not surprising since Tang and Ng allowed three to five search terms per case while our subjects were limited to three in order to complete the study within a reasonable time period.2 Furthermore, in the Tang and

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Table 2  
Breakdown of Results by Participant, Condition and Search Type  
(√ represents a correct diagnosis; X represents an incorrect diagnosis)

<table>
<thead>
<tr>
<th>Anterior Eye Conditions</th>
<th>Students 1 to 6 used Aston e-library only</th>
<th>Students 7 to 12 used Aston e-library + Google</th>
<th>Aston e-Library only no. of correct diagnoses</th>
<th>Aston e-Library + Google no. of correct diagnoses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6</td>
<td>7 8 9 10 11 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keratoglobus</td>
<td>X √ X X X X</td>
<td>X X X X X</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Marginal infiltrates</td>
<td>X X X X X X</td>
<td>X X X X X</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Dendritic ulcer</td>
<td>√ X X X X X</td>
<td>X √ √ √ √ √</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Chalazion</td>
<td>X X X X X X</td>
<td>√ √ √ √ √ √</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Posterior capsular opacification</td>
<td>X X X √ √ X</td>
<td>X X X √ √ √ √ √</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total no. correct anterior eye condition diagnoses</strong></td>
<td>4 15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Posterior Eye Conditions | Students 1 to 6 used Aston e-library + Google | Students 7 to 12 used Aston e-library only | | |
|--------------------------|---------------------------------------------|---------------------------------------------| | |
|                         | 1 2 3 4 5 6                           | 7 8 9 10 11 12                              | | |
| Commotio retinae         | X √ X X X X                           | X X X X X                                 | 0                                           | 2                                             |
| Lattice degeneration     | √ √ X X X X                           | X X X X X                                 | 3                                           | 5                                             |
| Systemic lupus erythematos | X X X X X X | X X X X X X | 0                                           | 0                                             |
| Central retinal vein occlusion | X X √ √ √ √ X | X √ X √ √ X | 4                                           | 4                                             |
| Coat’s disease           | √ √ √ √ X X                           | X √ √ √ √                              | 5                                           | 5                                             |
| **Total no. correct posterior eye condition diagnoses** | 12 16                                   |                                             |                                               |                                               |

| | Sum of total no. of correct anterior and posterior condition diagnoses/60 | 16 31                                   |

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Ng study participants chose the three most likely diagnoses that seemed to fit the symptoms and signs provided for each case and if one of those was correct the search was regarded as successful. Our subjects were limited to making one diagnosis as in our opinion this related better to the real-world clinical setting.

Siempos et al. used the same 26 cases as Tang and Ng and asked four physicians and four non-physicians to select three potential diagnoses for each case. If one of the three diagnoses was correct, the search was regarded as successful. The physicians had a 50.9% (95% CI 37.4-64.5%) success rate, which is broadly similar to that found in the current study. However, as in the Tang and Ng study, differential diagnosis encompassing three possibilities has a many times greater chance of hitting on the right diagnosis than a single attempt.

Our subjects worked on 10 simulated cases while those in the Tang and Ng and Siempos et al. studies worked on 26 actual cases. It is not clear how the success rate of our participants would have been affected by a greater number of cases and whether the fact that our cases were simulated made any difference to our findings. A difference in diagnosis success rate between anterior and posterior conditions was noted. The Aston e-library group did worse than the Aston e-library plus Google group for the anterior segment conditions (4 vs. 15 correct diagnoses respectively) while for the posterior segment conditions they were closer (12 vs. 16 correct diagnoses respectively). The cause of this is not clear to us. Students had approximately the same exposure during their education (year 1, year 2 and 11/24 weeks in year 3) to the anterior and posterior conditions that were used in the study. This difference in success rate between anterior and posterior conditions could relate to a difference in the teaching skills or styles of the faculty who lectured on anterior and posterior segment conditions or it may simply have occurred by chance.

Google is free and without registration although some of the sites found by Google may require subscription. A person who is not affiliated to a large medical center or university will benefit from the availability of, and quick access to, research material from a knowledge base that is increasing. With the advent of smartphones and tablet devices, a convenient computer is not required to access Google, just internet connectivity. In a recent comparative study of the usability in obtaining medical and health information of four popular internet search engines, Google had the best search validity in terms of whether a website could be opened.

The number of people with internet access is increasing and thus patients and not only physicians may have access to medical information. Giustini asked: “Is an observer who can accurately select the findings to be entered in a Google search all we need for a diagnosis to appear?” Our response to this question is no. The efficiency of the search is determined by the choice of key words and this will depend on the experience of the practitioner. Our third-year optometry students had a basic level of experience. An experienced practitioner more efficient at selecting key words and at identifying key documents from the Google search is likely to have a better diagnosis rate.

An outcome that emerged from this study is the need to be able to identify key words that will aid in web-based diagnosis. Training in this area has been incorporated into our optometry program and computer software that allows second-year students to practice investigating and managing virtual patients using standard computer systems has been developed. Part of the investigation aspect involves choosing key words from signs and symptoms generated by the software for each virtual patient. Evaluation of this software is being undertaken and will be published as part of a PhD thesis in 2015.

Falagas et al. noted that internet sources are more useful in uncommon cases than for ordinary diagnostic problems where a good medical background is likely to be sufficient. The authors agree with Giustini, who advocated the use of a Google search tool (Google Scholar) in addition to PubMed, Web of Knowledge and/or Cochrane in searches for clinical trials and systematic reviews and Google alone where quick diagnosis is required.

In terms of future work, it would be interesting to repeat the study using experienced qualified practitioners and also to determine the patient’s perception of a clinician’s ability if Google is used in front of them and to evaluate this in an educational and practice setting. Furthermore, as the determination of key words is critical in the success of Google as a diagnostic tool, the authors plan additional studies to examine the analysis of key words in relationship to success of diagnosis or the clinical reasoning used by students to determine key words.

Finally, it is our opinion that while it is reasonable for modern eyecare practitioners to be familiar with internet resources, make proper use of them, and to be as up-to-date as possible, clinical experience cannot be substituted but only complemented by the internet.

**Conclusion**

Google is a useful aid in helping optometry students improve success rate when diagnosing eye conditions. This is independent of previous academic performance. Skill in choosing key words from clinical cases is important when using internet search engines to aid clinical diagnosis. Training in selecting key words should be part of the optometry degree curriculum. Further research using a similar protocol with experienced eyecare practitioners and another study investigating the patient’s perception of the use of Google as a diagnostic aid is planned.

**References**