Google Search Queries About Neurosurgical Topics: Are They a Suitable Guide for Neurosurgeons?

Anna C. Lawson McLean, Aaron Lawson McLean, Rolf Kalff, Jan Walter

■ OBJECTIVE: **Google is the most popular search engine, with about 100 billion searches per month. Google Trends is an integrated tool that allows users to obtain Google's search popularity statistics from the last decade. Our aim was to evaluate whether Google Trends is a useful tool to assess the public's interest in specific neurosurgical topics.**

■ METHODS: **We evaluated Google Trends statistics for the neurosurgical search topic areas "hydrocephalus," "spinal stenosis," "concussion," "vestibular schwannoma," and "cerebral arteriovenous malformation." We compared these with bibliometric data from PubMed and epidemiologic data from the German Federal Monitoring Agency. In addition, we assessed Google users' search behavior for the search terms "glioblastoma" and "meningioma."**

■ RESULTS: **Over the last 10 years, there has been an increasing interest in the topic "concussion" from Internet users in general and scientists. "Spinal stenosis," "concussion," and "vestibular schwannoma" are topics that are of special interest in high-income countries (eg, Germany), whereas "hydrocephalus" is a popular topic in low- and middle-income countries. The Google-defined top searches within these topic areas revealed more detail about people's interests (eg, "normal pressure hydrocephalus" or "football concussion" ranked among the most popular search queries within the corresponding topics). There was a similar volume of queries for "glioblastoma" and "meningioma."**

■ CONCLUSIONS: **Google Trends is a useful source to elicit information about general trends in peoples' health interests and the role of different diseases across the world. The Internet presence of neurosurgical units and surgeons can be guided by online users' interests to achieve high-quality, professional-endorsed patient education.**

INTRODUCTION

Increasing numbers of patients make use of the Internet to find information about certain disorders or to share their experiences with other users. By analyzing the Internet users' searching behavior, physicians may be able to learn which neurosurgical topics the public are interested in. This information could help to 1) gain a better understanding of the average patient's background knowledge, 2) improve the physician–patient interaction, and 3) develop strategies for well-coordinated public relations work.

The most widely used search engine, with over 1 billion users and 100 billion searches per month,[1,2] Google offers a freely accessible implemented statistical tool called Google Trends, which depicts the amount of search queries over a period of time.

In 2009, Google Trends received public attention when scientists discovered that searching behavior of Google users could be used to identify general trends in the spreading of influenza in the United States.[3] Increasing rates of infection as reported by the Centers for Disease Control and Prevention correlated with increasing search queries. Recently, there have been several suggestions to improve the accuracy of Google Flu Trends[4,5] and there have been attempts to correlate Google Trends to other pandemic infectious diseases.[6]

The aim of this study was to evaluate whether Google Trends could also be a useful tool for neurosurgeons to assess the public's interest in different neurosurgical conditions.

METHODS

Google Trends depicts the amount of certain search queries per week based on a relative scale. The week with the overall highest

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number of search queries receives 100 points and all other weeks are viewed in relation to that week. There are 2 methods available from Google Trends to assess the users' search behavior: search terms include only queries including the exact term, whereas search topics include all queries within the field of interest. As of 2015, search topics was in beta mode and not all keywords are implemented into topics. Therefore, in this study both methods were assessed.

We obtained Google Trends data from the last 10 years for the following search topics: "hydrocephalus," "concussion," "vestibular schwannoma," "spinal stenosis," and "cerebral arteriovenous malformation." This choice of topics was selected from the limited range of topics within the current, beta version of Google Trends. Despite the limited range, we sought to include 1 topic from each of the main fields of neurosurgery: spinal surgery, tumor surgery, vascular surgery, trauma surgery, and cerebrospinal fluid disorders. Google Trends data were evaluated with respect to the amount of search queries, both worldwide and within Germany, so-called top searches (ie, most common expressions related to the search topic), and worldwide distributions of search queries.

To compare Google search queries with the volume of scientific publications during this period, PubMed publication data were acquired for the Medical Subject Headings terms corresponding to the above-mentioned search topics: "hydrocephalus," "brain concussion," "neuroma, acoustic," "spinal stenosis," and "intracranial arteriovenous malformation." PubMed publication data present the total number of publications per year.

For comparison of public interest as determined from Google Trends with disease prevalence, the total number of diagnoses per year according to the *International Classification of Diseases Version 10, German Modification* was obtained from the Federal Health Monitoring Agency of Germany.

In addition, we assessed Google Trends data for the following search terms: "neurosurgery," "glioblastoma," and "meningioma."

All data were obtained on 11 January 2015. The data on the number of PubMed publications were updated on 23 October 2015 to include publications from 2014 that were listed with a delay.

RESULTS

Overall Search Topic and PubMed Results

Over the last 10 years, there has been an increasing interest in the topic "concussion." This trend is reflected both in worldwide Google search queries (Figure 1) and in the number of publications in medical journals (Figure 2). Within search results from Germany, there was an exceptionally high peak for this search topic in the week of 29 December 2013 until 4 January 2014, correlating with a significant national news event. The worldwide amount of search queries mostly remained stable for the topics "hydrocephalus," "spinal stenosis," and "cerebral arteriovenous malformation" and shows a slight decrease for the topic "vestibular schwannoma." The number of publications on PubMed, on the other hand, has continuously increased over the last decade for all of the subjects mentioned except "hydrocephalus." The Medical Subject Headings term "brain concussion" reveals the steepest curve over the last 8 years.

Number of Diagnoses According to *International Classification of Diseases Version 10, German Modification*

From 2004 until 2014, there was a dramatic increase in the number of diagnoses of spinal stenosis within Germany (with a percentage increase of 134% over this period). There have also been increases in the number of cases of concussion, intracranial arteriovenous malformation, and hydrocephalus over this period (+31.9%, +26.9%, and +28.8%, respectively). The number of diagnosed benign cranial nerve tumors remained largely stable (−9.11%; Figure 3).

Top Searches

The so-called top searches on Google Trends show the most frequent search queries that contain words associated with the search topics. "Concussions in football," "concussions in sports," and "Crosby concussion" (which relates to the brain concussion of an American ice hockey player) were among the top searches within the topic "concussion." Google users appeared to be especially interested in congenital forms of hydrocephalus (top searches were "hydrocephalus baby," "spina bifida") and treatment ("hydrocephalus shunt," "hydrocephalus treatment," "VP shunt").

Within the topic "spinal stenosis," Google users were mostly interested in treatment ("spinal stenosis surgery," "spinal stenosis treatment," "laminectomy," "spondylolisthesis"). The interest in cervical spinal stenosis ("stenosis cervical," "cervical spinal stenosis," "stenosis neck," "cervical spine," "cervical stenosis symptoms," "cervical stenosis neck") was similar to that of lumbar spinal stenosis ("lumbar stenosis," "lumbar spinal stenosis," "canal lombaire etroit," "lumbar spine," "lumbar canal stenosis").

The top searches within "vestibular schwannoma" were mainly therapy-related ("acoustic neuroma surgery," "acoustic neuroma treatment," "gamma knife," "vestibular schwannoma surgery," "akustikusneurinom operation").

There were no sublevel terms within the top-level topic "cerebral arteriovenous malformations."

Geographic Aspects

Next, we looked at the worldwide distribution of the 5 search topics. The maps in Figure 4 indicate the top 10 countries for each one of them. Apparently, "spinal stenosis," "concussion," and "vestibular schwannoma" are mainly searched for in high-income countries, such as the United States, parts of western and northern Europe, and Australia, whereas "hydrocephalus" appears to be of most concern in low- and middle-income countries like Colombia, Kazakhstan, and Kenya. "Cerebral arteriovenous malformation" mostly raises interest in Japan and the United States.

Search Term Results

The search terms "glioblastoma" and "meningioma" have shown similar search rates over the last 10 years (Figure 5). There was a peak of the search term "glioblastoma" in October–November 2014.

In regard to the search term "neurosurgery," we found that there has been decreasing interest over the last decade. Alongside "journal neurosurgery" and "best neurosurgeons," Google users were frequently interested in "neurosurgery salary."

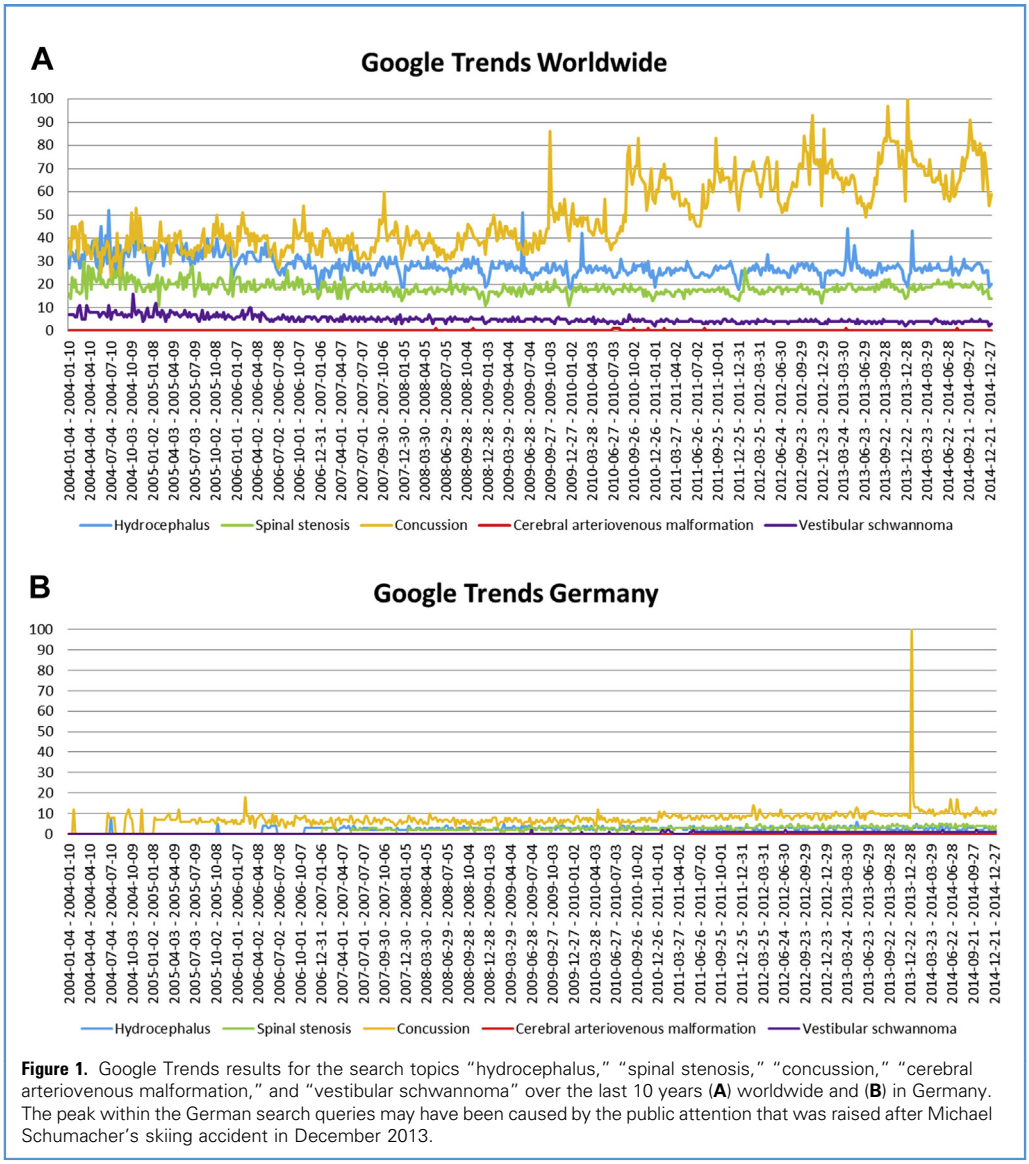

Figure 1. Google Trends results for the search topics "hydrocephalus," "spinal stenosis," "concussion," "cerebral arteriovenous malformation," and "vestibular schwannoma" over the last 10 years (**A**) worldwide and (**B**) in Germany. The peak within the German search queries may have been caused by the public attention that was raised after Michael Schumacher's skiing accident in December 2013.

DISCUSSION

Overall Search Behavior

The results show the differences in interest for the different topics within neurosurgery. More common conditions, such as hydrocephalus and concussion, are searched for more often than rarer conditions like vestibular schwannoma or arteriovenous malformation. With the exception of "concussion," the public's interest in all of the included conditions has remained stable over the last 10 years. In contrast, the number of publications per year on 4 of the investigated topics has increased over time, as has the number of diagnoses of 4 of the conditions we explored.

There has been a boost in the public's and scientists' interest in the topic "concussion" over the last 10 years. This correlates with an increasing number of cases of concussion in clinical practice according to federal data. A further explanation might be the increasing scientific and public recognition of the issue of chronic traumatic encephalopathy among retired contact sports professionals.[7] For example, the high-ranking search term "Crosby concussion" refers to the American ice hockey player Sidney Crosby, who was unable to play for some time after suffering a sports-related brain injury.[8] The increased interest in this topic among the German population at the end of 2013 may have a similar origin: in late December 2013, the illustrious German Formula 1 car racing driver Michael Schumacher had a recreational skiing accident resulting in severe traumatic brain injury. The news became omnipresent and the mechanisms, treatment, and prognosis of traumatic brain injury were discussed throughout screen and print media.[9]

The number of search queries for the search terms "glioblastoma" and "meningioma" has been comparable over the last 10 years. Similar search rates correlate with similar incidence rates of

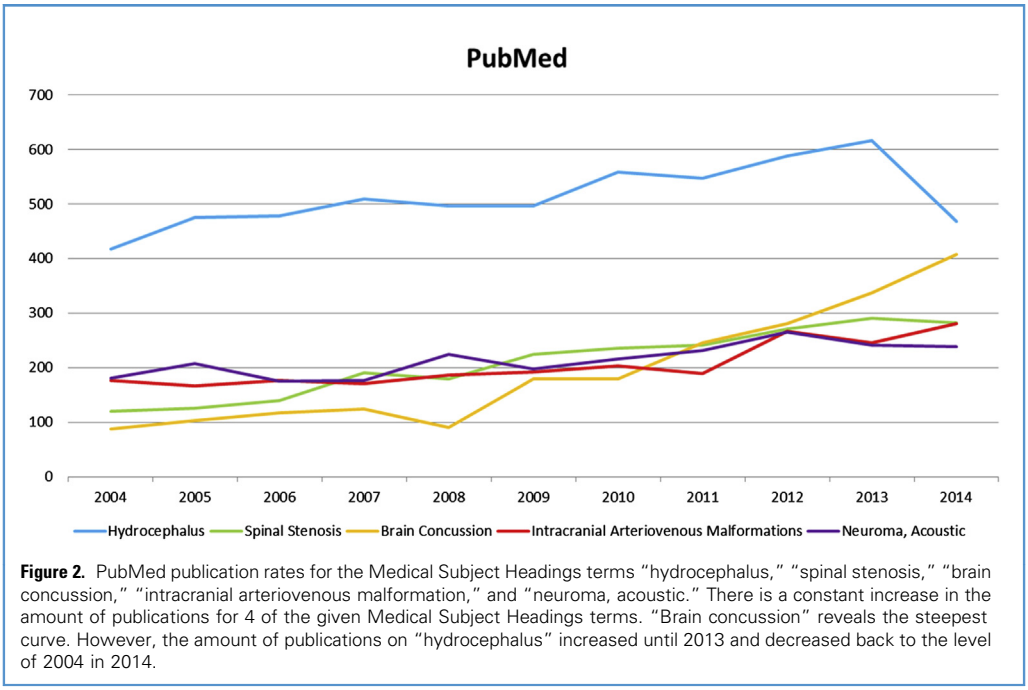

Figure 2. PubMed publication rates for the Medical Subject Headings terms "hydrocephalus," "spinal stenosis," "brain concussion," "intracranial arteriovenous malformation," and "neuroma, acoustic." There is a constant increase in the amount of publications for 4 of the given Medical Subject Headings terms. "Brain concussion" reveals the steepest curve. However, the amount of publications on "hydrocephalus" increased until 2013 and decreased back to the level of 2004 in 2014.

both kinds of tumors.[10,11] The cause of the peak of interest in glioblastomas in October–November 2014 remains unclear.

Geographic Aspects

Our data suggest that the interest in different medical conditions also depends on geographic aspects. For example, congenital malformations such as hydrocephalus are more searched for in economically less-advanced nations, whereas diseases of the elderly, such as spinal stenosis, are searched for in high-income countries. This may reflect elements like the age distribution and impact of these conditions on individuals in these societies. The dramatic increase in the incidence of spinal stenosis in Germany is an example of this development. Arteriovenous malformations appear to be of interest only in Japan and the United

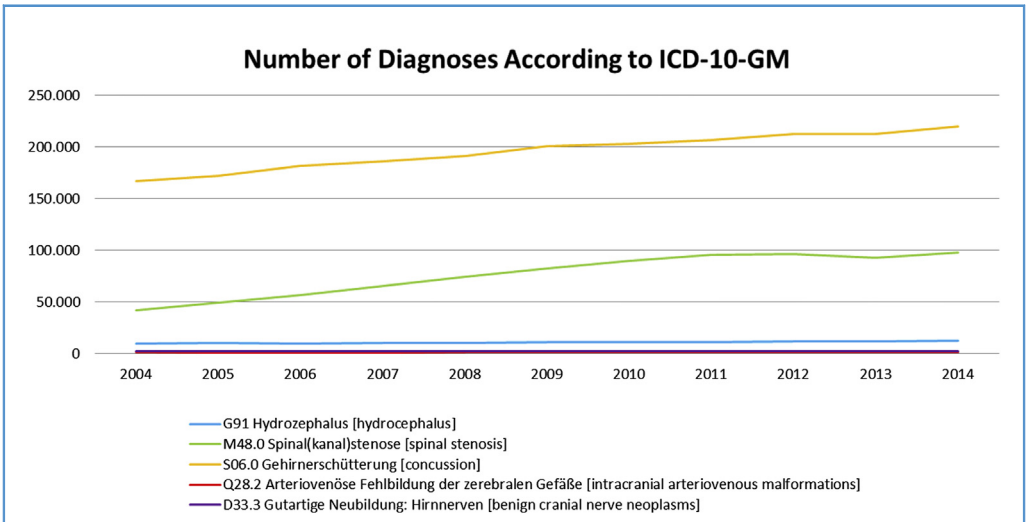

Figure 3. Number of diagnoses according to the *International Classification of Diseases Version 10, German Modification* from 2004 until 2014. There was an increase in the number of diagnoses of concussion, spinal stenosis, hydrocephalus, and arteriovenous malformation per year within Germany, whereas the rate of diagnoses of benign cranial nerve tumors remained stable.

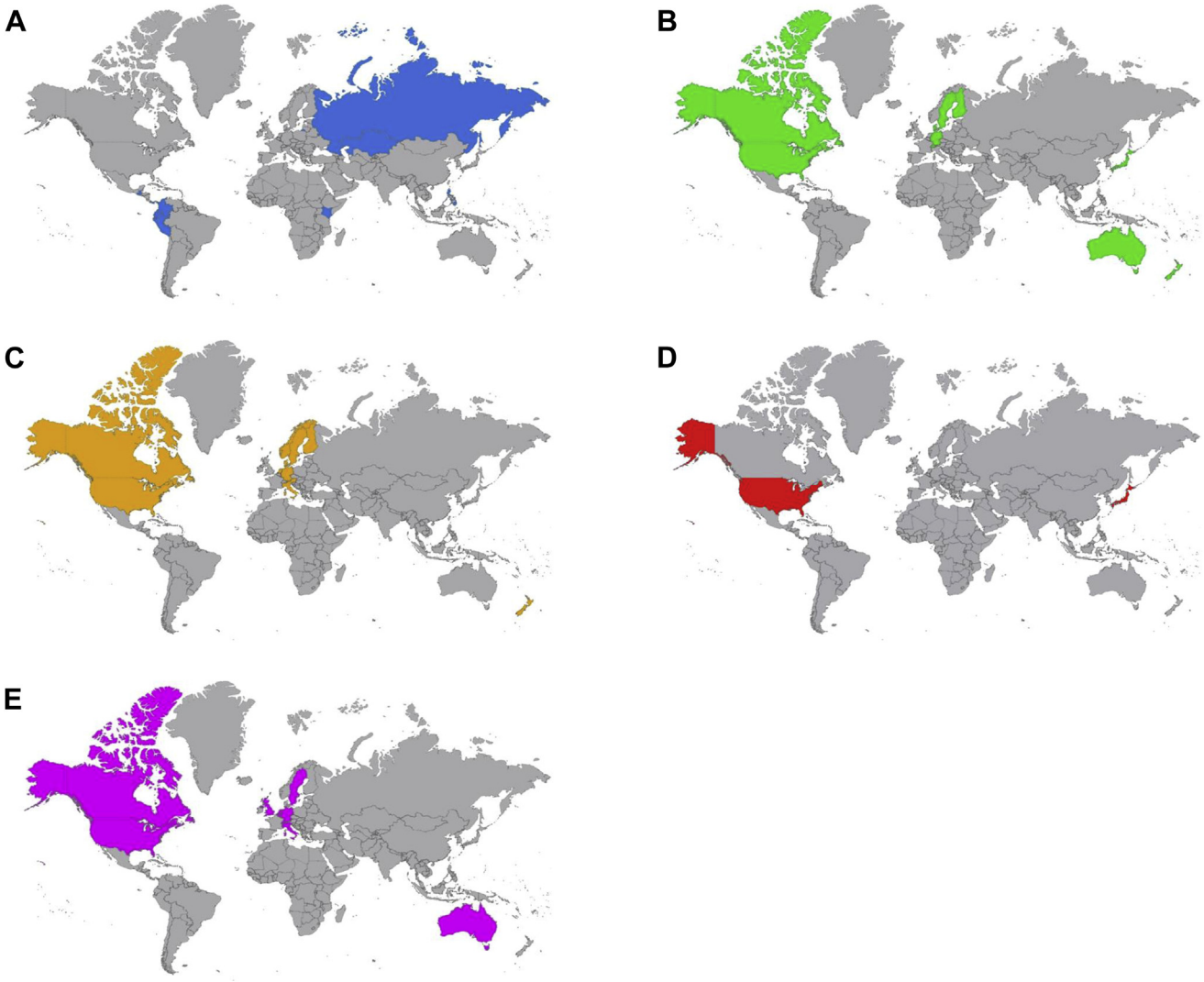

Figure 4. Top 10 countries for the search topics (**A**) "hydrocephalus", (**B**) "spinal stenosis," (**C**) "concussion," (**D**) "cerebral arteriovenous malformation," and (**E**) "vestibular schwannoma."

States. This may be explained by the relatively higher prevalence of arteriovenous malformation compared with aneurysms in the Asian population[12] and the generally low search rates for this topic.

Relevance of our Findings to Clinical Practice

There are several ways in which the information gained from Google Trends can influence the way surgeons connect with the public in general and with their patients in particular. Topics that are of special interest at a certain time (potentially because of a widely acclaimed public event or media focus) can be used as a discussion starter at public education symposia or in consultations or bedside discussions with patients and their families. On the hospital Web site or in social media, there could be updates on interesting topics in an accessible style for members of the public. Alotaibi and colleagues[13] recently evaluated the presence of neurosurgical units in North America in social media and highlighted its potentially influential role in education and as a platform for discussion.

It is clear from the literature that patients and the public look for health-related information online, with 70% of adults using the Internet as their first source for health information.[14,15] From our data, it is evident that there is sustained worldwide interest among the public in many important neurosurgical conditions. Despite this interest, patients have recognized difficulties in finding and accessing desired health information online,[16,17] and Web-based patient-directed information is of variable quality and readability.[18-26] Instead of leaving patients to find their own way online, neurosurgeons may wish to guide patients to more reliable

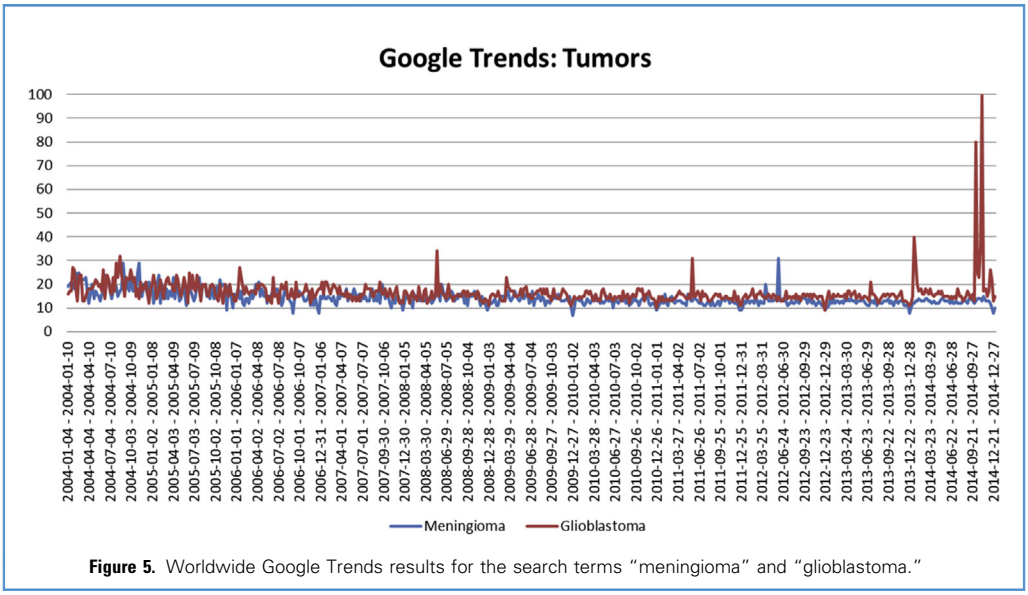

Figure 5. Worldwide Google Trends results for the search terms "meningioma" and "glioblastoma."

Internet resources to encourage understanding of their conditions, to promote self-management, and to facilitate health literacy.

Google Trends may also prepare resident and less-experienced attending surgeons for questions that patients and their families are likely to have. For instance, our results suggest that within the topic vestibular schwannoma, there is a wide and sustained interest in radiosurgical treatment; patients may have some level of understanding about this form of therapy from their Web-based searches and might expect a more detailed and individualized explanation from their neurosurgeon.

Furthermore, our findings may have valuable clinical implications, because an increase in public awareness and understanding of neurosurgical conditions (eg, the symptoms caused by brain tumors) could result in earlier presentation and better prognosis. Of course, it is not clear that information-seeking behavior reliably translates into appropriate health-seeking behavior.

The use of Google Trends may also enable public health officials and campaign organizers to evaluate and better scrutinize the success of disease awareness and public engagement activities. For example, using Google Trends data, Murray and colleagues[27] demonstrated that the number of search queries for oral cancer in Ireland increased significantly between 2005 and 2013, after the introduction of a national Mouth Cancer Awareness Day. Similarly, Glynn et al.[28] showed an increase in search activity for breast cancer that reliably coincided with a month devoted to nationwide breast cancer awareness, also in Ireland.

Limitations

Limitations to our study are mainly secondary to the scoring system implemented in Google Trends. Google Trends normalizes and scales data between 0 and 100 (peak), and all other data over different periods are presented relative to that peak. This allows only relative judgments and requires the user to compare between different groups. In addition, the intentions and motivations underlying users' search queries are not clearly assessable. Also, repeated searches by the same user cannot be differentiated from novel searches. Better visualization of the mapping between search terms and topics in Google Trends is desirable.

CONCLUSIONS

Google Trends is an interesting tool for neurosurgeons that offers the possibility to detect general trends and dynamics in the public's interest in neurosurgical topics. It hints at which aspects of certain diseases and treatment the public are especially keen to learn about. The goal should be to answer these questions through public relations work, such as on the hospital Web site and social media presence or in-hospital patient information points. Particularly in this digital era, it is important for health care facilities and professionals to provide relevant and understandable patient information, to educate patients about their conditions, and to offer an accredited alternative to less reliable Internet and nonscientific publications.

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