



# Modern internet search analytics and thyroidectomy: What are patients asking?

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## Abstract

**Objectives:** Thyroidectomy is among the most commonly performed head and neck surgeries, however, limited existing information is available on topics of interest and concern to patients.

**Study Design:** Observational.

**Setting:** Online.

**Methods:** A search engine optimization tool was utilized to extract metadata on Google-suggested questions that “People Also Ask” (PAA) pertaining to “thyroidectomy” and “thyroid surgery.” These questions were categorized by Rothwell criteria and topics of interest. *The Journal of the American Medical Association* (JAMA) benchmark criteria enabled quality assessment.

**Results:** A total of 250 PAA questions were analyzed. Future-oriented PAA questions describing what to expect during and after the surgery on topics such as postoperative management, risks or complications of surgery, and technical details were significantly less popular among the “thyroid surgery” group ( $P < 0.001$ ,  $P = 0.005$ , and  $P < 0.001$ , respectively). PAA questions about scarring and hypocalcemia were nearly threefold more popular than those related to pain (335 and 319 vs. 113 combined search engine response page count, respectively). The overall JAMA quality score remained low ( $2.50 \pm 1.07$ ), despite an increasing number of patients searching for “thyroidectomy” ( $r(77) = 0.30$ ,  $P = 0.007$ ).

**Conclusions:** Patients searching for the nonspecific term “thyroid surgery” received a curated collection of PAA questions that were significantly less likely to educate them on what to expect during and after surgery, as compared to patients with higher health literacy who search with the term “thyroidectomy.” This suggests that the content of PAA questions differs based on the presumed health literacy of the internet user.

## KEYWORDS

information quality, online health education, search analytics, thyroid surgery, thyroidectomy

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[Correction added on 24 August 2023, after first online publication: CONFLICT OF INTEREST section is updated.]

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### Key points

- Significant findings of the study:
  - o Cosmesis and hypocalcemia as top questions as opposed to nerve injury is both an unexpected and interesting finding.
  - o Google may curate results differently based on patient health literacy.
- What this study adds:
  - o Patients undergoing endocrine procedures are increasingly referencing online health information before their clinic visit. Understanding the most popular topics of patient interest on a nation-wide level may inform patient counseling efforts.

## INTRODUCTION

With the rise of the information technology era, worldwide internet use has grown significantly: there are >4.5 billion internet users today, accounting for more than 55% of the global population.<sup>1,2</sup> This rise in internet consumption has played a dramatic role in how individuals access healthcare information, with approximately 70% of US adults conducting health-related Google searches each year.<sup>3</sup> Besides being the most utilized search engine worldwide, Google is uniquely poised to answer patient's questions as its search engine implements a machine-learning-based system (RankBrain) in combination with a natural language processing technology (Bidirectional Encoder Representations from Transformers, BERT) to not only accurately identify search patterns and intentions, but also predict a user's questions given their original search query.<sup>1,4</sup> Once a query is entered, the search engine provides a list of questions that are most commonly asked regarding that search query ("People Also Ask," PAA), along with a search engine response page (SERP) with links to websites that it predicts will answer those questions.<sup>1,4,5</sup>

The rise of e-Health information poses a significant concern for patient education, as the quality and content of the sources distributing medical information on Google are highly variable, and the information provided is frequently inaccurate or incomplete.<sup>3</sup> This growing concern regarding misinformation from health-based websites led to the creation of the *Journal of the American Medical Association* (JAMA) Benchmark criteria, a set of standardized guidelines to encourage a high standard of health information on the Internet.<sup>3</sup>

The impact and quality of online patient education materials (PEMs) retrieved from sources such as Google and YouTube have since been thoroughly investigated in the cancer patient population.<sup>6-10</sup> However, little is known about the specific topics of patient interest and the nature of the information provided. No prior study has systematically investigated the most popular questions asked by patients or the quality of the sources to which such inquiries would be directed. Although prior reports have examined the readability, understandability, and actionability of the top websites pertaining to thyroidectomy, the scope of these reports was limited to just ≤31 sources without an investigation of top patient questions or a quality assessment using JAMA criteria.<sup>11,12</sup>

Given that more than 93,000 thyroidectomies are performed each year,<sup>13</sup> and that high-quality online PEM can improve health outcomes,<sup>14,15</sup> alleviate patients' emotional distress,<sup>16,17</sup> and reduce healthcare costs,<sup>18-20</sup> it is imperative that patient information needs are systematically assessed. To address the paucity of literature on this topic, we sought to (1) investigate and characterize information sought and questions asked (PAAs) and (2) systematically appraise the quality of PEMs using JAMA benchmark criteria.

## MATERIALS AND METHODS

The most popular PAA questions for each search term were obtained using the search engine optimization tool, SearchResponse.io (<https://searchresponse.io/people-also-ask>). This tool analyzes data from >100 million PAA questions collected from Google across >200 million keywords in the current calendar year (2022). PAAs are presented in a rank-ordered list based on popularity. After a user submits their search query, the resulting page of results is referred to as a SERP. This SERP is composed of 3 types of information: organic search results, paid search/pay-per-click (PPC) results that appear with the word "Ad" in bolded font, and PAA questions clustered in a drop-down menu. Importantly, PAA questions are not searched but rather suggested by machine learning algorithms embedded into the Google software. Therefore, the popularity of a PAA question is measured by the number of SERPs in which the PAA appears, rather than the number of users typing that particular question into Google. This study exclusively utilized a publicly available database and was deemed exempt from review by the Institutional Review Board at the University of Pennsylvania.

### Question classification

The most common Google search PAA questions associated with the keywords "thyroidectomy" and "thyroid surgery" were extracted and characterized. Importantly, "thyroidectomy" is a technical term used to describe a surgical procedure wherein thyroid tissue is removed. The use of this search term may be indicative of a higher health literacy. In

contrast, “thyroid surgery” is an umbrella-term, which could refer to potentially many distinct procedures, including isthmusectomy, total thyroidectomy, hemithyroidectomy, subtotal thyroidectomy, open thyroid biopsy, and perhaps minimally-invasive interventional endocrinology procedures such as percutaneous ultrasound-guided ethanol ablation or radiofrequency ablation. It is thought that use of this general and ill-defined term of “thyroid surgery” could be indicative of lower health literacy. A comprehensive list of top PAAs for “thyroidectomy” and “thyroid surgery” was generated separately to enable comparative analysis (Supporting Information: Table S1). A low popularity score (appearing in <5 SERPs) was used as a cut off for inclusion. This produced 100 PAAs for “thyroidectomy” and 150 PAAs for “thyroid surgery” keywords. This methodology was adapted from recent reports using online search analytics to investigate patient interest in surgical procedures.<sup>1,4</sup> Question types were categorized based on Rothwell's system for classification (Fact, Value, and Policy).<sup>21,22</sup> Similar to a recent report by Shen et al. questions were further subclassified into 10 topics

relevant to surgical procedures (Table 1).<sup>4</sup> A comprehensive assessment of concerns unique to patients undergoing thyroid removal were also investigated.

## Website categorization, quality assessment, and volume trend analysis

All 250 PAAs were categorized by affiliation type (Academic, Commercial, Government, Medical Practice, Single Surgeon, Personal, Social Media) similar to prior reports (Supporting Information: Table S1).<sup>3,7,10,11</sup> Websites associated with the top 20 most popular PAAs were assessed using JAMA benchmark criteria,<sup>11</sup> in accordance with the existing literature.<sup>7,12-15</sup> Quality assessment using JAMA criteria is based on authorship, attribution, currency, and disclosure. Websites meeting all criteria must include: authors and contributors with their affiliations and credentials (Authorship); references and sources for content with

**TABLE 1** Classification of question types (modified Rothwell's criteria<sup>a</sup>).

Rothwell category		Description
Fact		Asks whether something is true and to what extent. This type of question is answered with objective evidence.
Policy		Asks whether a specific course of action should be undertaken to solve a problem.
Value		Asks for an evaluation of the desirability of an object, idea, event, or person. This type of question is answered with subjective evidence.
Topic category		
Fact	Activities or restrictions	Specific activities or actions after the procedure that can/cannot be done
	Timeline of recovery	Expected length of time for recovery
	Technical Details	Procedural methods, description of procedure steps, how procedure achieves results, surgeon credentials
	Cost	Cost of procedure
	Risks or complications	Types of operative risks associated with the procedure
Policy	Indications	Purpose of procedure, candidacy criteria, when the procedure indicated
	Postoperative management	Management and types of postoperative complications
Value	Preoperative appraisal	Assessment before surgery
	Postoperative experience or pain	Expectations and evaluation after surgery
	Longevity	Duration and stability of outcomes
	Evaluation of alternative treatments	Nonsurgical approaches, at-home solutions, alternative techniques
Website category		
Academic		Institutions directly affiliated with universities, academic medical centers, or academic societies
Commercial		Organizations serving as source of health information
Government		Websites with “.gov” domain or otherwise maintained by a governmental agency
Medical Practice		Website maintained by group of physicians without an academic affiliation.
Single Surgeon		Website maintained by a single physician without an academic affiliation.
Social Media		Focus on communication, community-based input, interaction, and content-sharing

<sup>a</sup>Rothwell JD. In *Mixed Company: Communicating in Small Groups*. Boston, MA: Wadsworth; 2010.

copyright information (Attribution); dates of publication, revision, or updating (Currency); and ownership, sponsorship, advertising, underwriting, and/or funding support for the website (Disclosure). Possible JAMA scores range from 0 to 4. A score of 0 indicates that no JAMA criteria were met. A score of 4 indicates that all JAMA criteria were met. To compare quality of websites in various categories, average JAMA scores were calculated by website affiliation type.

### Independent reviewer assessment

Two independent reviewers (N.S. and C.F.) classified PAAs according to Rothwell criteria, topic category, and website affiliation type (Supporting Information: Table S1). Content quality was assessed by JAMA benchmark criteria. A third party (E.D.R.) was consulted to resolve discordance between reviewers.

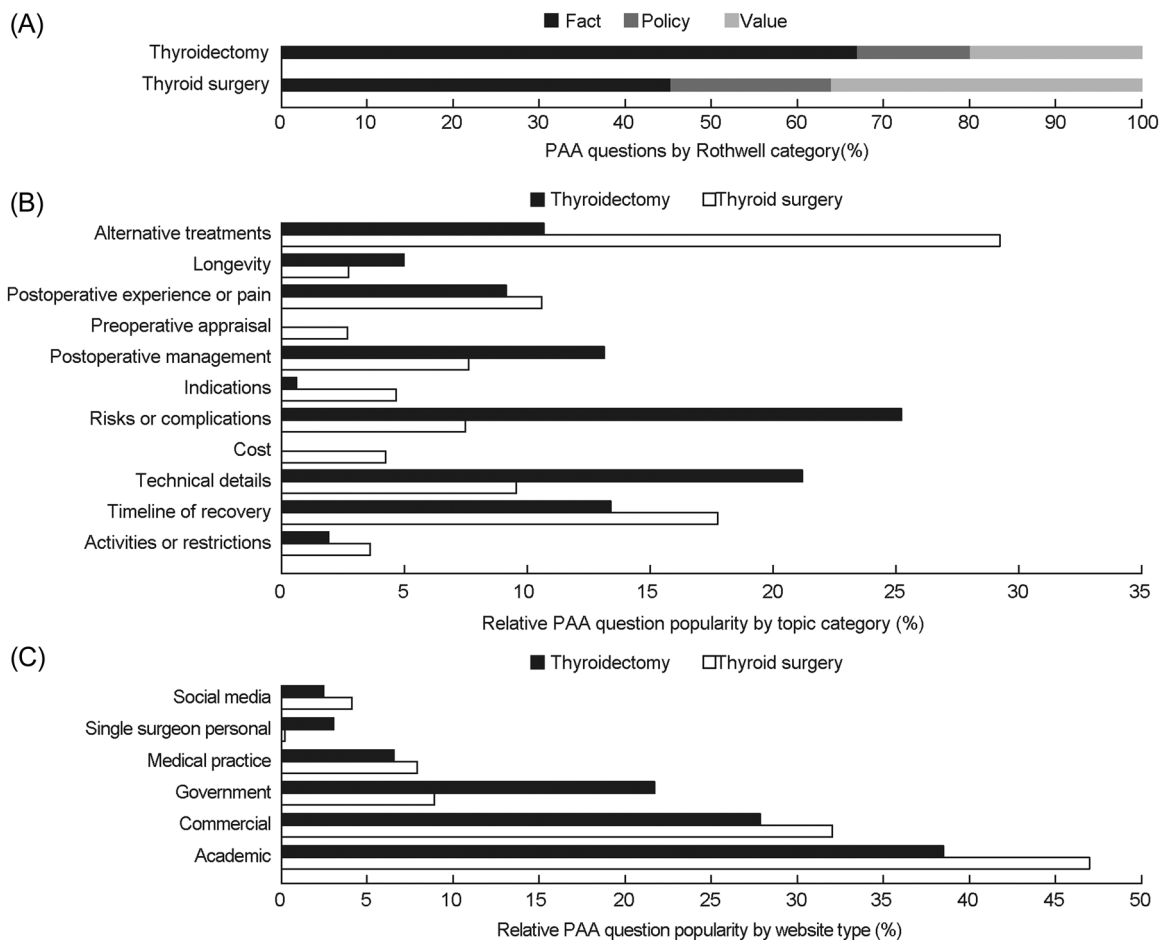
### Statistical analysis

Differences in sample means were assessed with the Student *t* test. Chi-squared ( $\chi^2$ ) tests were used to describe differences between groups,

except for in cases of small-sized samples wherein Fisher's exact test was employed. Levene's test verified that no significant differences existed in the variances of groups. Pearson's *R* was used to measure the strength of linear relationships between variables. A two-tailed *P* = 0.05 was considered statistically significant. Statistical analyses were performed using SPSS (version 24; IBM).

## RESULTS

PAA questions categorized by Rothwell category for the keyword "thyroidectomy" (*n* = 100) included 67.0% fact, 13.0% policy, and 20.0% value. For PAA questions from the "thyroid surgery" group (*n* = 150), there were fewer fact (45.3%), a similar proportion of policy (18.7%), and more value (36.0%) (Figure 1). Taken together, PAA questions pertaining to the keywords "thyroidectomy" and "thyroid surgery" most commonly referenced the following topics: risks or complications of surgery (18.6%), evaluation and possible alternatives (17.5%), technical details of surgery (16.8%), and timeline of recovery (15.0%). Upon stratification, there were significant differences in the relative popularity of PAA topics resulting from "thyroidectomy" and "thyroid surgery." PAA topics that were significantly more popular in the thyroidectomy



**FIGURE 1** Question categorization. (A) Percentage of People Also Ask (PAA) questions by Rothwell category. (B) Popularity of PAA questions by topic category. (C) Popularity of PAA questions by website category. Statistically significant differences (*P* < 0.05) between categories are denoted with an asterisk.

group included: postoperative management (13.1% vs. 7.6%,  $t = 4.44$ ,  $P < 0.001$ ); risks or complications of surgery (25.2% vs. 7.4%,  $t = 2.93$ ,  $P = 0.005$ ); technical details (21.1% vs. 9.5%,  $t = 4.54$ ,  $P < 0.001$ ). PAA questions concerning evaluation and alternative treatment (10.6% vs. 29.2%,  $t = 4.93$ ,  $P < 0.001$ ) were significantly more common among the thyroid surgery group.

### Characterization by website affiliation

Website sources supplying prepopulated answers to PAA questions were mostly from academic institutions (41.1%), commercial organizations (29.3%), and government databases (16.3%). Upon stratification, there were significant differences in the relative popularity of PAA website affiliations resulting from “thyroidectomy” and “thyroid surgery” (Figure 1). Sources from government websites were more commonly used to answer top PAA questions in the “thyroidectomy” group ( $t = 3.39$ ,  $P = 0.002$ ), whereas significantly more academic websites were used to answer questions in the “thyroid surgery” group ( $t = 4.15$ ,  $P < 0.001$ ).

### Patient concerns assessed by popularity (SERP count)

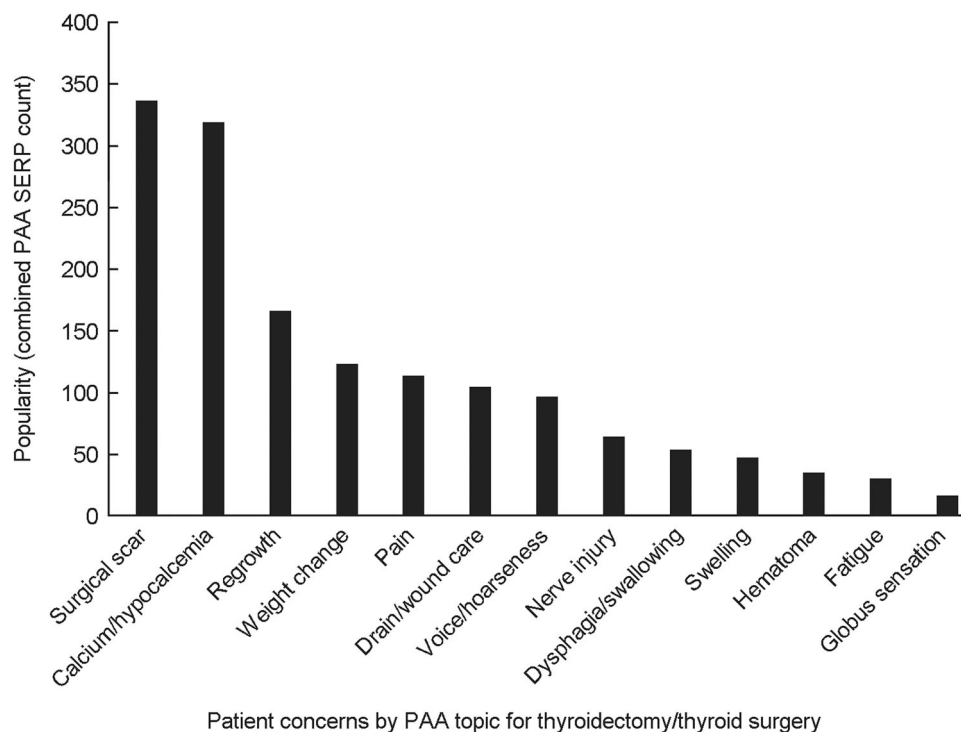
Recurring topics specific to thyroid removal were apparent upon review. Topics of concern pertained to postsurgical scarring, calcium/hypocalcemia, thyroid regrowth, weight change, pain, and so forth (Figure 2). PAA questions falling into identified topic categories were grouped together and a summation of the SERP popularity for these PAA questions was calculated. From this analysis, it was found that the most popular PAA

questions concerned postoperative scarring and calcium/hypocalcemia, which were nearly three times more popular than PAA questions related to pain (335 and 319 vs. 113 combined SERP count, respectively).

Less popular PAA question topics pertained to nerve injury (64), dysphagia/swallowing (53), swelling (47), hematoma (35), fatigue (30), and globus sensation (17) (Supporting Information: Table S2).

### JAMA criteria quality assessment

The top 25 most popular PAA source websites were assessed using the JAMA benchmark criteria for website quality (Table 2). After removal of five duplicate websites, the top 20 unique websites were appraised in four domains by two independent reviewers. Sources for these websites included nine academic (45.0%), five commercial (25.0%), three government (15.0%), one medical practice (5.0%), one single surgeon (5.0%), and one social media (5.0%). The overall JAMA quality score was  $2.50 \pm 1.07$ . Within website categories, heterogeneous JAMA scores were observed. Several academic websites received low JAMA scores, resulting in a mean score of  $2.11 \pm 1.10$ . Commercial and governmental websites received higher average JAMA scores than academic websites in aggregate ( $3.20 \pm 0.75$  and  $3.33 \pm 0.47$ , respectively), although this was not statistically significant (analysis of variance  $F = 2.70$ ,  $P = 0.102$ ). Only four of the most popular websites (20.0%) met all four JAMA benchmark criteria. There was no significant difference in JAMA scores between PAA sources for “thyroidectomy” ( $n = 14$ ,  $2.43 \pm 0.98$ ) and “thyroid surgery” ( $n = 6$ ,  $2.67 \pm 1.25$ ) ( $t = 0.434$ ,  $P = 0.670$ ). Few websites categorized as medical practice, single surgeon, or social media were



**FIGURE 2** Specific patient concerns pertaining to thyroidectomy/thyroid surgery. PAA, People Also Ask.

**TABLE 2** Top search results assessed by the *Journal of the American Medical Association (JAMA)* benchmark criteria.

Website affiliation	Keyword	JAMA score <sup>a</sup>	Popularity (SERP count) <sup>b</sup>	Category	URL
Healthgrades	Thyroid surgery	4	222	Commercial	<a href="https://www.healthgrades.com/right-care/thyroid-removal-surgery">https://www.healthgrades.com/right-care/thyroid-removal-surgery</a>
Pubmed	Thyroidectomy	4	210	Government	<a href="https://pubmed.ncbi.nlm.nih.gov/23746996/">https://pubmed.ncbi.nlm.nih.gov/23746996/</a>
Larian MD	Thyroidectomy	1	141	Single Surgeon	<a href="https://larianmd.com/types-thyroid-surgery/">https://larianmd.com/types-thyroid-surgery/</a>
Penn Medicine	Thyroidectomy	1	135	Academic	<a href="https://www.penmedicine.org/for-patients-and-visitors/find-a-program-or-service/surgery/thyroid-surgery/what-to-expect-at-penn">https://www.penmedicine.org/for-patients-and-visitors/find-a-program-or-service/surgery/thyroid-surgery/what-to-expect-at-penn</a>
National Health Service (UK)	Thyroidectomy	2	127	Academic	<a href="https://www.ouh.nhs.uk/patient-guide/leaflets/files/12764Thyroidectomy.pdf">https://www.ouh.nhs.uk/patient-guide/leaflets/files/12764Thyroidectomy.pdf</a>
Hopkins Medicine	Thyroid surgery	1	124	Academic	<a href="https://www.hopkinsmedicine.org/surgery/specialty-areas/surgical-oncology/endocrine/patient_information/thyroid_surgery.html">https://www.hopkinsmedicine.org/surgery/specialty-areas/surgical-oncology/endocrine/patient_information/thyroid_surgery.html</a>
American Thyroid Association	Thyroidectomy	2	116	Commercial	<a href="https://www.thyroid.org/patient-thyroid-information/what-are-thyroid-problems-q-and-a-thyroidectomy/">https://www.thyroid.org/patient-thyroid-information/what-are-thyroid-problems-q-and-a-thyroidectomy/</a>
News24 (South Africa)	Thyroidectomy	2	115	Social Media	<a href="https://www.news24.com/health24/Experts/DietDoc/metabolism-boost-after-thyroidectomy-20071025">https://www.news24.com/health24/Experts/DietDoc/metabolism-boost-after-thyroidectomy-20071025</a>
Pubmed	Thyroidectomy	3	115	Government	<a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3185817/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3185817/</a>
Drugs.com	Thyroidectomy	3	109	Commercial	<a href="https://www.drugs.com/cg/partial-thyroidectomy.html">https://www.drugs.com/cg/partial-thyroidectomy.html</a>
UT Southwestern Medical Center	Thyroid surgery	3	104	Academic	<a href="https://utswmed.org/medblog/thyroid-nodule-radiofrequency-ablation-rfa/">https://utswmed.org/medblog/thyroid-nodule-radiofrequency-ablation-rfa/</a>
Medscape	Thyroidectomy	4	97	Commercial	<a href="https://www.medscape.com/answers/1891109-100643/what-is-the-immediate-postoperative-course-for-patients-who-have-undergone-thyroidectomy">https://www.medscape.com/answers/1891109-100643/what-is-the-immediate-postoperative-course-for-patients-who-have-undergone-thyroidectomy</a>
Oncology Nurse Advisor	Thyroidectomy	3	94	Commercial	<a href="https://www.oncologynurseadvisor.com/home/departments/advisor-forum/managing-tsh-levels-after-total-thyroidectomy/">https://www.oncologynurseadvisor.com/home/departments/advisor-forum/managing-tsh-levels-after-total-thyroidectomy/</a>
KarenZupko & Associates	Thyroidectomy	2	85	Medical Practice	<a href="https://www.karenzupko.com/total-thyroidectomy-reimplantation-parathyroids/">https://www.karenzupko.com/total-thyroidectomy-reimplantation-parathyroids/</a>
Research Gate	Thyroidectomy	3	79	Academic	<a href="https://www.researchgate.net/figure/List-of-included-CPT-codes-60220-Total-thyroid-lobectomy-unilateral-with-or-without_tbl1_262538421">https://www.researchgate.net/figure/List-of-included-CPT-codes-60220-Total-thyroid-lobectomy-unilateral-with-or-without_tbl1_262538421</a>
Mayo Clinic	Thyroid surgery	4	78	Academic	<a href="https://www.mayoclinic.org/tests-procedures/thyroidectomy/about/pac-20385195">https://www.mayoclinic.org/tests-procedures/thyroidectomy/about/pac-20385195</a>
Hopkins Medicine	Thyroid surgery	1	77	Academic	<a href="https://www.hopkinsmedicine.org/health/conditions-and-diseases/thyroid-nodules-when-to-worry">https://www.hopkinsmedicine.org/health/conditions-and-diseases/thyroid-nodules-when-to-worry</a>
ICD10Data.com	Thyroidectomy	2	75	Academic	<a href="https://www.icd10data.com/ICD10CM/Codes/Z00-Z99/Z77-Z99/Z90-Z90.89">https://www.icd10data.com/ICD10CM/Codes/Z00-Z99/Z77-Z99/Z90-Z90.89</a>
AccessAnesthesiology	thyroidectomy	3	71	Academic	<a href="https://accessanesthesiology.mhmedical.com/content.aspx?bookid=1750&amp;sectionid=117321503">https://accessanesthesiology.mhmedical.com/content.aspx?bookid=1750&amp;sectionid=117321503</a>
MyHealth.Alberta.ca	Thyroid surgery	3	66	Government	<a href="https://myhealth.alberta.ca/Health/aftercareinformation/pages/conditions.aspx?hwid=zc2552">https://myhealth.alberta.ca/Health/aftercareinformation/pages/conditions.aspx?hwid=zc2552</a>

<sup>a</sup>JAMA score is based on authorship, attribution, currency, and disclosure. One point is awarded for meeting each of these criteria, which results in a total score between 0 and 4.

<sup>b</sup>The popularity metric is based on search engine response page (SERP) count, which is the number of unique searches in which a particular people also ask (PAA) question appears.

observed within the top PAA website sources, but those that did appear had the lowest quality of patient educational materials, as evidenced by JAMA scores of 1–2.

## Search trends

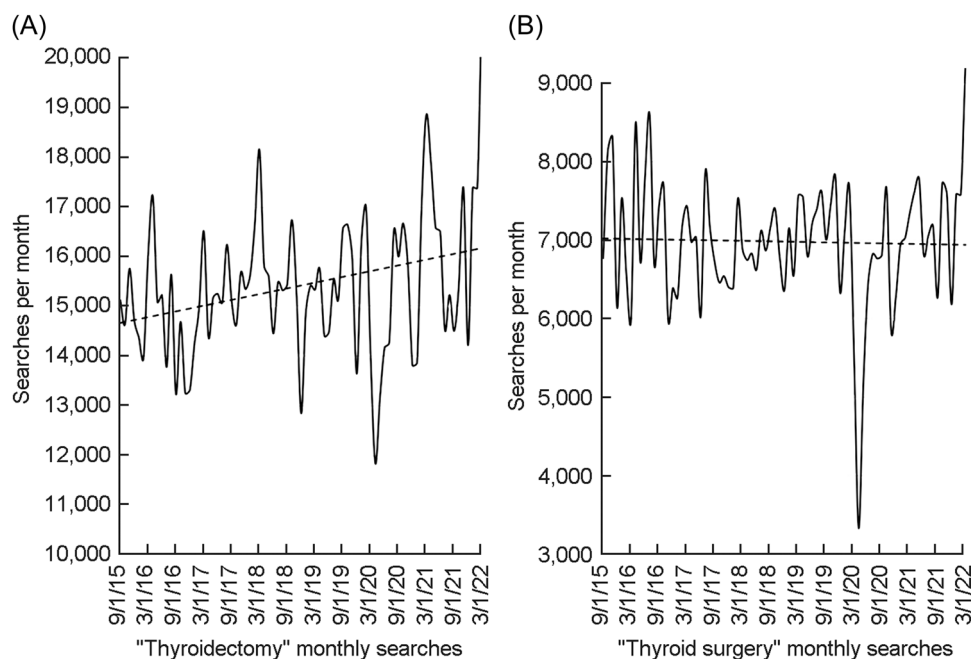
Since September 2015 there has been a significant increase in the volume of monthly searches for “thyroidectomy” ( $r(77) = 0.30, P = 0.007$ ) and a slight decreasing trend for the searches pertaining to “thyroid surgery” ( $r(77) = -0.03, P = 0.815$ ) (Figure 3). There is no discernable seasonal trend in query volumes for either of these search terms. At the onset of the coronavirus pandemic in 2020, there was sharp decline in search volumes for both terms, however, search volumes have since rebounded to new all-time highs in early 2022. Users searching for “thyroidectomy” most commonly originated from the United States (7.4 K searches/month, 56%), India (1.2 K, 9%), United Kingdom (900, 6%), Canada (600, 4%), and Australia (500, 3%). Similarly, users searching for “thyroid surgery” most commonly originated from the United States (17 K, 43%), India (5.5 K, 14%), United Kingdom (2.8 K, 7%), Philippines (2.5 K, 6%), and Australia (1.6 K, 4%).

## DISCUSSION

The number of patients seeking health information online is increasing each year. Up to (87%) of patients with thyroid cancer will utilize the internet to supplement their knowledge, and many patients will inquire about treatment options such as thyroidectomy, in particular.<sup>23,24</sup> Our understanding of what these patients seek to

understand and to where they are directed remains limited. Using machine-learning and language processing technology, pioneering Google analytic software is able to predict a user's interests based on the patterns and intentions of prior users. This process automatically generates a list of highly pertinent questions most commonly asked in association with the initial search query. These questions that ‘People Also Ask’ are useful to understand from a clinical perspective because they provide unique insight into patient curiosity that can be captured and quantified. Topics of interest are identified from a bottom-up rather than top-down approach, which is to say that topic categories originate directly from the searches rather than the researchers. This reduces observer methodology biases, thereby avoiding common pitfalls that limit traditional clinical research surveys seeking to understand areas of patient interest. The nationwide sample size ensures excellent generalizability of results and captures tens of thousands of unique searches. The findings presented herein represent the first rigorous analysis of what patients search for on the internet regarding thyroidectomy and thyroid surgery.

Before this report, topics of importance to patients undergoing thyroidectomy were poorly understood. Two prior studies assessed the readability of online patient education materials, both of which revealed that information was presented at a higher level than recommended by NIH and AMA readability guidelines.<sup>11,12</sup> Neither study sheds light on why patients were consulting these resources or what questions were of most interest to this patient population. A small survey ( $n = 54$ ) recently found that patients tend to be most interested in postoperative side effects, including weight gain, tiredness, and changes in mood.<sup>25</sup> Sawka et al.<sup>26–28</sup> found that thyroid cancer patients were most concerned about treatment side



**FIGURE 3** Search query trends (volume/month). (A) Thyroidectomy. (B) Thyroid surgery.

effects. A report comparing traditional and transoral approaches highlighted patient interest in scarless thyroidectomy.<sup>29</sup> Taken together, there was a paucity of literature on the concerns and topics of interest to patients undergoing thyroid surgery such as thyroidectomy.

## Commonly asked questions

We found that PAA questions were relatively evenly dispersed within the 11 topic categories, with no single category having more than 30% of the total SERP popularity (Figure 1). Stratification by keyword “thyroidectomy” or “thyroid surgery” revealed several significant differences in popularity of the topic categories. We suspect that these differences are a result of the patient population using each term. In particular, it could be that patients with higher health literacy are more likely to use the technical term “thyroidectomy,” whereas patients with lower health literacy are more likely to use the general term “thyroid surgery.” This characterization may explain why patients searching for “thyroidectomy” were significantly more likely to receive future-oriented PAA questions describing what to expect during and after the surgery. Such questions were related to postoperative management ( $t = 4.44$ ,  $P < 0.001$ ); risks or complications of surgery ( $t = 2.93$ ,  $P = 0.005$ ); and technical details ( $t = 4.54$ ,  $P < 0.001$ ).

In contrast, patients searching for the keywords “thyroid surgery” who may have a relatively lower health literacy were significantly more likely to be presented with PAA questions that were not future-oriented. Such questions did not educate that patient on what to expect during or after the surgery. These patients were significantly more likely to receive PAA questions describing evaluation/alternative treatments ( $t = 4.93$ ,  $P < 0.001$ ). This finding highlights that there is room for improvement in Google’s machine-learning technology. Patients with lower health literacy would benefit more from a curated collection of PAA questions that help set expectations before surgery. At this point in time, Google is presenting said patient populations with PAA questions that are less likely to prepare patients for future surgery. This issue could be resolved through collaborative efforts between technology companies and healthcare providers with expertise on the subject.

## Patient concerns assessed by popularity (SERP count)

The most popular topics of concern pertained to postoperative scarring and calcium/hypocalcemia (Figure 2). Interestingly, there are actionable steps that can be taken to address these top patient concerns. In response to a growing desire to avoid a scar, various approaches for endoscopic thyroidectomy have been developed. Such approaches include minimally invasive video-assisted thyroidectomy,<sup>30</sup> anterior cervical,<sup>31</sup> and lateral cervical routes.<sup>32</sup> Also available are extracervical routes that include, for example, a breast approach,<sup>33</sup> transaxillary approach,<sup>34</sup> postauricular approach,<sup>35</sup> and

transoral approach,<sup>36</sup> with some being performed robotically. Moreover, several techniques are available to avoid postoperative hypocalcemia, the most common complication of thyroidectomy.<sup>37</sup> Fluorescent technologies for intraoperative parathyroid identification, as well as nano-carbon tracers with lymphatic system tropism, have been increasingly employed to avoid inadvertent parathyroid tissue resection during thyroid surgery.<sup>38,39</sup> Given the strong patient interest in scarring and hypocalcemia that was identified and quantified herein, we recommend a thorough discussion of postoperative expectations regarding scarring and hypocalcemia. It is also worth discussing minimally invasive approaches during the pre-surgical consultation and developing a standard postoperative calcium regimen with endocrinologists.

## Website quality

Prior studies have examined the quality of top thyroidectomy websites using indirect proxy metrics such as readability, understandability, actionability, and clinical practice guideline compatibility of the top websites.<sup>11,12</sup> These studies revealed website content to be poorly understandable or actionable. This characterization of poor quality is consistent with our assessment of website quality using the JAMA benchmark criteria. We found that JAMA scores were highly variable and no website type was identified as having particularly high average JAMA scores. Only four of the most popular websites (20.0%) met all four JAMA benchmark criteria. Given that the volume of searches conducted on the keyword “thyroidectomy” is significantly increasing, especially in the year of our writing, it is becoming ever-more important to address the current gap in quality of patient education resources that are presented to patients by Google’s PAA algorithms.

## Implications and limitations

Although popular PAAs were identified from SearchResponse.io, the interpretation of PAA popularity is challenging. Popularity was assessed based on the number of SERPs in which the PAAs will appear. Given that some internet searches are more common than others, the absolute number of SERPs that present a given PAA is not necessarily equivalent to the number of patients who will see that PAA. A major assumption of this report is that people searching for “thyroid surgery” have less health literacy than those searching for “thyroidectomy.” Although this is a limitation, the authors do believe that the reported differences in types of questions asked do support this assumption and indicate that the two terms are not equivalent or interchangeable. Moreover, our analysis did assume that searches were conducted by patients, however, it is not possible to know who was searching or their intent. Because Google tracks individual search patterns and locations when presenting customized search results, it is possible that suggested PAAs may differ between users. It is also important to note that websites can include accurate and valuable



content in the setting of low on JAMA score. Insufficient information on authorship, attribution, disclosure, and currency are the only variables contributing to a low JAMA quality score.

## CONCLUSION

The content of clickable questions automatically presented by Google differed based on the presumed health literacy of the internet user. For this reason, the authors recommend that patients search using the term “thyroidectomy” to gain additional insight into postoperative management, risks or complications of surgery, and technical details. Interestingly, patients are more interested in postoperative cosmesis and hypocalcemia than nerve injury. Equipped with these findings, physicians, academic institutions, and commercial organizations can better curate educational content and tailor counseling efforts to meet patient informational needs surrounding thyroidectomy.

## AUTHOR CONTRIBUTIONS

**Neeraj Suresh:** Design, conduct, analysis, presentation. **Christian Fritz:** Design, conduct, presentation. **Emma De Ravin:** Design, conduct, presentation. **Karthik Rajasekaran:** Design, conduct, presentation.

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The authors have nothing to report.

## CONFLICT OF INTEREST STATEMENT

Professor Karthik Rajasekaran is a member of World Journal of Otorhinolaryngology – Head & Neck Surgery (WJOHNS) editorial board and is not involved in the peer review process of this article. The other authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

Relevant data included in supplemental tables.

## ETHICS STATEMENT

This report did not involve human or animal subjects and was deemed exempt from review by the institutional review board affiliated with the senior author's department.

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### SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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