

Comparison of PubMed and Google Scholar Literature Searches

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BACKGROUND: Literature searches are essential to evidence-based respiratory care. To conduct literature searches, respiratory therapists rely on search engines to retrieve information, but there is a dearth of literature on the comparative efficiencies of search engines for researching clinical questions in respiratory care. **OBJECTIVE:** To compare PubMed and Google Scholar search results for clinical topics in respiratory care to that of a benchmark. **METHODS:** We performed literature searches with PubMed and Google Scholar, on 3 clinical topics. In PubMed we used the Clinical Queries search filter. In Google Scholar we used the search filters in the Advanced Scholar Search option. We used the reference list of a related Cochrane Collaboration evidence-based systematic review as the benchmark for each of the search results. We calculated recall (sensitivity) and precision (positive predictive value) with 2×2 contingency tables. We compared the results with the chi-square test of independence and Fisher's exact test. **RESULTS:** PubMed and Google Scholar had similar recall for both overall search results (71% vs 69%) and full-text results (43% vs 51%). PubMed had better precision than Google Scholar for both overall search results (13% vs 0.07%, $P < .001$) and full-text results (8% vs 0.05%, $P < .001$). **CONCLUSIONS:** Our results suggest that PubMed searches with the Clinical Queries filter are more precise than with the Advanced Scholar Search in Google Scholar for respiratory care topics. PubMed appears to be more practical to conduct efficient, valid searches for informing evidence-based patient-care protocols, for guiding the care of individual patients, and for educational purposes. *Key words:* information storage and retrieval; PubMed; Google Scholar. [Respir Care 2010;55(5):578–583. © 2010 Daedalus Enterprises]

Introduction

The task force established by the American Association for Respiratory Care to create a vision for the future emphasized the importance of evidence-based practice.¹ To inform evidence-based practice, respiratory therapists (RTs) need efficient information-retrieval strategies for relevant, well designed research studies. Search engines help to find, filter, and retrieve information from the World Wide Web.²

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PubMed (<http://www.ncbi.nlm.nih.gov/sites/entrez?db=pubmed>), offered by the National Library of Medicine, is a free search engine for searching biomedical journal literature. It searches several databases and directly interfaces with MEDLINE, the National Library of Medicine's database of citations from biomedical journals. The National Library of Medicine updates MEDLINE citations daily and uses the National Library of Medicine's Medical Subject Headings to index each article. PubMed maps users' search terms to the Medical Subject Headings and text words in MEDLINE records. Additionally, PubMed offers numerous powerful search filters. Some view these attributes as an "unwelcoming complexity."³ The PubMed Clinical Queries search filter is, however, easy to use, while highly sensitive and precise in retrieving scientifically valid evidence from MEDLINE.⁴

Google Scholar (<http://scholar.google.com>) is a search engine for a wide range of academic fields. It searches for scholarly publications, including peer-reviewed articles, theses, books, and abstracts from academic publishers, pro-

fessional societies, pre-print sources, and universities. Google Scholar is a subset of the Google search engine (<http://google.com>). Like Google, Google Scholar is simple, fast, and provides broad coverage: characteristics that our information-rich culture highly values. Within 1 year of its introduction as a beta version in 2004, Google Scholar surpassed PubMed in the number of referrals to many online biomedical journals.⁵ However, Google Scholar has come under criticism for a lack of advanced search features, insufficient indexing, an unclear definition of its database content, a concealed search algorithm, and incompleteness.⁶⁻⁹ Google Scholar appears to have only indirect, partial access to MEDLINE, with relatively infrequent updates,^{6-8,10} so it may lack the most current MEDLINE publications. Nor does Google Scholar map search terms to the National Library of Medicine's Medical Subject Headings.⁶ Although Google Scholar includes articles from PubMed, it apparently does so incompletely.⁶ Nevertheless, an increasing proportion of people are accessing PubMed citations with searches that begin in either Google or Google Scholar.¹¹

Previous reports have reviewed both PubMed and Google Scholar, but there is a dearth of literature on the comparative efficiency of search engines for clinical questions in respiratory care. We compared PubMed and Google Scholar literature search results for several respiratory care topics.

Methods

Design

Because this study lacked human subjects, the study protocol did not require institutional review board approval. A cross-sectional study design was used.

Procedure

From a list of systematic reviews on the Web site of the Cochrane Collaboration (<http://www.cochrane.org>) we selected 3 respiratory care clinical topics of interest to us, to represent in-patient care, out-patient care, and pediatrics (Table 1).¹²⁻¹⁴ From the title of each Cochrane review we selected 2 common clinical terms as search terms, connected by the Boolean operator "AND" (see Table 1). We accessed PubMed via a link from our library's Web site, which provided access to full-text articles from journals to which our university library subscribes. In the PubMed searches we used the Clinical Queries function, with the "therapy" and "narrow, specific" search strategies (Fig. 1), which automatically combine the search terms with the following filters:

randomized controlled trial[Publication Type] OR
(randomized[Title/Abstract] AND controlled[Title/
Abstract] AND trial[Title/Abstract])

Table 1. Characteristics of the Literature Searches

Topic	Search Terms
Noninvasive positive-pressure ventilation for cardiogenic pulmonary edema ¹²	"noninvasive positive-pressure ventilation" AND "pulmonary edema"
Self-management education and regular practitioner review for adults with asthma ¹³	"asthma" AND "education"
Ribavirin for respiratory syncytial virus ¹⁴	"ribavirin" AND "respiratory syncytial virus"



Fig. 1. PubMed search with Clinical Queries filter.

as outlined at the National Center for Biotechnology Information Web site (www.pubmed.gov).

For the Google Scholar searches, in the Scholar Preferences section we established a library link with the University of Arkansas for Medical Sciences to enable access to full-text articles available through the university's subscriptions (Fig. 2). We used the Advanced Scholar Search option. In the "Find articles...with all of the words" space we entered the 2 search terms. We limited the subject area

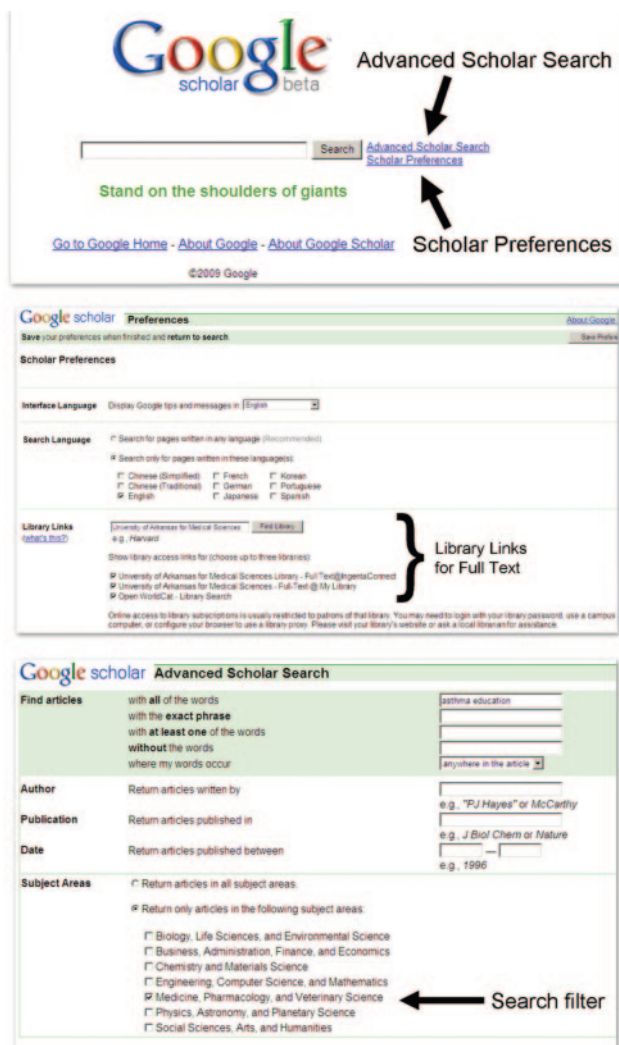


Fig. 2. Google Scholar Advanced Scholar Search.

to “Medicine, Pharmacology, and Veterinary Science” (see Fig. 2). Because Google Scholar returned an exceedingly high number of search results, to cross-reference the Cochrane references, we repeated the searches with the first author’s first and last name entered in the “Author... Return articles written by” space and the search terms in the “Find articles....with all of the words” space.

For each clinical topic we used the reference list of a corresponding Cochrane review as the benchmark by which we analyzed the PubMed and Google Scholar search results. In the Cochrane reviews the researchers retrieved information from multiple databases, including MEDLINE, the Cochrane Airways Group trial register (derived from MEDLINE), the Cochrane Central Register of Controlled Trials, EMBASE, the Cumulative Index to Nursing and Allied Health Literature, the Database of Abstracts of Reviews of Effects, the National Health Service Economic Evaluation Database, the Acute Respiratory Infections

Group’s specialized register, and the Latin American and Caribbean Health Sciences Literature. We excluded abstracts, conference proceedings, and responses to letters to the editor from the Cochrane reviews reference lists.

Measurements

Our primary measurements were recall (sensitivity) and precision (positive predictive value). We calculated recall as:

$$\text{True positives}/(\text{true positives} + \text{false negatives})$$

For example, for a PubMed search we calculated recall as the number of articles in both the PubMed search results and the corresponding Cochrane review reference list, divided by the sum of the number of articles in both the PubMed search results and the Cochrane review reference list plus the number of articles in the Cochrane reference list but not in the PubMed search.

A higher recall is desirable because it increases the probability that the search results include important, valid articles.

We calculated precision as:

$$\text{True positives}/(\text{true positives} + \text{false positives})$$

For example, for a PubMed search we calculated precision as the number of articles in both the PubMed search results and the Cochrane review reference list divided by the sum of the number of articles in both the PubMed search results and the Cochrane review reference list plus the number of articles in the PubMed search results but not in the Cochrane review reference list.

A higher precision is desirable because it reflects a more specific, efficient search.

Statistical Analysis

We used graphics software (GraphPad, GraphPad Software, La Jolla, California) to create 2×2 contingency tables. We used the chi-square test of independence or Fisher’s Exact test for contingency tables with a cell-count of less than 5, and tested for significant differences in sensitivity and positive predictive values between the PubMed and Google Scholar literature searches (2-sided $\alpha = .05$).

Results

For the 3 literature searches combined, PubMed and Google Scholar had a similar recall for both the overall search results and the availability of full-text articles. PubMed had better precision, which reflected specificity or efficiency (Table 2). In the individual literature searches, PubMed and Google Scholar had similar recall, with the exception of the ribavirin literature search, for which

Table 2. Differences in Proportions for All Clinical Questions Combined

Measure	PubMed (n, %)	Google Scholar (n, %)	P
Recall*	59/83 (71)	57/83 (69)	0.87
Full-text recall*	36/83 (43)	42/83 (51)	0.44
Precision†	59/467 (13)	57/80,730 (0.07)	< .001
Full-text precision†	36/467 (8)	42/80,730 (0.05)	< .001

* Recall (sensitivity) = true positives/(true positives + false negatives)
† Precision (positive predictive value) = true positives/(true positives + false positives)

PubMed had a higher recall. For each individual search, PubMed had better precision (Table 3).

Discussion

The purpose of this study was to compare PubMed and Google Scholar search results for clinical questions in respiratory care. Our results suggest that PubMed, using the Clinical Queries search filter, is more precise (180 times greater for all citations and 154 times greater for full-text citations) than Google Scholar for finding valid studies included in the reference lists of related Cochrane reviews. These results are important because efficient retrieval of the best available scientific evidence can inform respiratory care protocols, recommendations for clinical decisions in individual patients, and education, while minimizing information overload.

Use of PubMed's Clinical Queries search filter, with the "narrow, specific" subfilter, helps to explain PubMed's higher specificity. Researchers from McMaster University developed the search strategies that the National Library of Medicine adopted for this filter. In a validation study of this filter, searches related to therapy, with the "narrow, specific" subfilter, yielded 93% sensitivity and 97% specificity for rigorously designed studies that were previously retrieved via hand-searching 170 journals.⁴ By automatically combining the user's search terms with filters for randomized, clinical trials, the "narrow, specific" subfilter effectively eliminates non-relevant information and poorly designed studies. We used the "narrow, specific" subfilter in PubMed, whereas in Google Scholar, because of the high number of search results, we conducted author searches within the topic searches. Still, sensitivity was similar between the 2 search engines.

In contrast to PubMed, Google Scholar searches a wide range of multidisciplinary topics and offers few options for filtering large amounts of information. It relies on an inherent algorithm to determine search results, and it lacks a filter similar to PubMed's Clinical Queries to search for rigorously designed studies. Google Scholar also lacks the capacity to map search terms to the MEDLINE Medical

Subject Headings.⁶ Given these inadequacies, Henderson concluded that Google Scholar is inappropriate as the sole alternative for clinicians.¹⁵ Google Scholar is still labeled as a beta version; perhaps future upgrades will address the shortcomings. For now, the optimal application of Google Scholar may be as an adjunct resource, for known authors or articles, or perhaps for initial searches to quickly find a relevant article.

Our use of the reference lists in Cochrane reviews as benchmarks strengthens this comparison of PubMed and Google Scholar. The Cochrane Collaboration is well respected for applying explicit, rigorous methods to regularly updated, premium evidence-based systematic reviews of pertinent clinical questions.¹⁶⁻¹⁹ Cochrane Collaboration researchers use exhaustive information-retrieval strategies, including medical databases, hand-searching of journals and conference proceedings, and contacting investigators about unpublished data.²⁰ The inclusion criteria for the selection of studies for Cochrane reviews are based on scientific merit. Many Cochrane reviews include only randomized controlled clinical trials. Although Cochrane reviews are an excellent resource for clinical information, it is often helpful to retrieve the original studies for details about the subjects, clinical setting, and methods. Reports of recent clinical trials may become available subsequent to a Cochrane review. Furthermore, only abstracts are available for free on the Cochrane Collaboration Web site; access to the full reviews is by subscription only.

The present study is a unique comparison of PubMed and Google Scholar for searches of respiratory care topics. Our results are consistent with those of previous studies, which targeted various clinical topics and used different methods, including PubMed search strategies other than the Clinical Queries filter. A study that targeted drug-information reviews and limited the comparison to the first 100 citations, determined that PubMed was more precise than Google Scholar.²¹ A search for clinical practice guidelines at SUMSearch (<http://sumsearch.uthscsa.edu>) was also found to be more precise than at Google Scholar.²² Shultz compared PubMed and Google Scholar, without a benchmark, in searching various topics, authors, and journals,²³ and the search results had little overlap. Shultz speculated that mapping search terms to MEDLINE Medical Subject Headings was an advantage for PubMed. In contrast, Walters reported that Google Scholar performed better than MEDLINE, but the benchmark for the comparison was a set of articles on later-life migration, a social science topic that is only indirectly related to biomedicine.²⁴ Hess reported that PubMed searches for respiratory care topics were inefficient, due to a large number of results, but neither was a comparison made with another search engine nor was the Clinical Queries filter used.¹⁶

COMPARISON OF PUBMED AND GOOGLE SCHOLAR LITERATURE SEARCHES

Table 3. Recall* and Precision† of the Literature Searches

	Asthma Education		Ribavirin and RSV		Noninvasive Ventilation	
	<i>n</i> (%)	<i>P</i>	<i>n</i> (%)	<i>P</i>	<i>n</i> (%)	<i>P</i>
Recall						
PubMed	30/47 (64)	.66	12/12 (100)	.04‡	17/24 (71)	> .99
Google Scholar	33/47 (70)		7/12 (58)		17/24 (71)	
Full-Text Recall§						
PubMed	18/47 (38)	.35	3/12 (25)	> .99	15/24 (62)	.76
Google Scholar	23/47 (49)		3/12 (25)		16/24 (67)	
Precision						
PubMed	30/394 (8)	< .001	12/29 (41)	< .001	17/44 (39)	< .001
Google Scholar	33/67,300 (<1)		7/3,600 (<1)		17/9,830 (<1)	
Full-Text Precision						
PubMed	18/394 (5)	< .001	3/29 (10)	< .001‡	15/44 (34)	< .001
Google Scholar	23/67,300 (<1)		3/3,600 (<1)		16/9,830 (<1)	

* Recall (sensitivity) = true positives/(true positives + false negatives).

† Precision (positive predictive value) = true positives/(true positives + false positives).

‡ Via Fisher's exact test.

§ Full-text recall = recall for references available in full text.

|| Full-text precision = precision for references available in full text.

RSV = respiratory syncytial virus

Limitations

For practical purposes, we overestimated the recall of Google Scholar, which yielded several thousand results (range 3,600–67,300). It is unlikely that users consider more than the first few hundred search results, so RTs who conduct literature searches with Google Scholar on these topics will be much less likely to find references cited in Cochrane reviews. To determine the recall and precision of Google Scholar we elicited the Cochrane references by conducting author searches within the topic search. This practice is not generalizable. Moreover, none of the Cochrane reviews that we used included a relatively recent study on a reference list; the most recent was published in 2005. Because Google Scholar apparently receives delayed updates from MEDLINE, important, recent studies could be missed, further reducing sensitivity. Additionally, both PubMed and Google Scholar yielded many articles with a full-text option, because the searches were linked with our university library. For users who are not associated with an organization that has contracts with publishers, fewer full-text articles may be available. Finally, we selected clinical topics from a list of systematic reviews on the Cochrane Collaboration Web site, which represented in-patient, out-patient, and pediatric respiratory care topics of interest to us. We used search terms that commonly apply to those topics. However, other search terms or topics could yield different results.

Conclusions

For efficient retrieval of valid studies in respiratory care, PubMed with the Clinical Queries filter appears to be pref-

erable to Google Scholar. Our results should be considered for evidence-based protocols, clinical questions in the care of individual patients, and for educational purposes. PubMed literature searches may have a broad impact on RTs, because access is free, PubMed maps the search terms to the MEDLINE Medical Subject Headings, and PubMed features the Clinical Queries filter, which is simple to use yet retrieves high-quality studies. As search engines continue to evolve, RTs will benefit from further critical evaluation of efficient ways to retrieve the best available scientific evidence.

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