Using the Turning Research Into Practice (TRIP) database: how do clinicians really search?*

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Objectives: Clinicians and patients are increasingly accessing information through Internet searches. This study aimed to examine clinicians' current search behavior when using the Turning Research Into Practice (TRIP) database to examine search engine use and the ways it might be improved.

Methods: A Web log analysis was undertaken of the TRIP database—a meta-search engine covering 150 health resources including MEDLINE, The Cochrane Library, and a variety of guidelines. The connectors for terms used in searches were studied, and observations were made of 9 users' search behavior when working with the TRIP database.

Results: Of 620,735 searches, most used a single term, and 12% (n = 75,947) used a Boolean operator: 11% (n = 69,006) used "AND" and 0.8% (n = 4,941) used "OR." Of the elements of a well-structured clinical question (population, intervention, comparator, and outcome), the population was most commonly used, while fewer searches included the intervention. Comparator and outcome were rarely used. Participants in the observational study were interested in learning how to formulate better searches.

Conclusions: Web log analysis showed most searches used a single term and no Boolean operators. Observational study revealed users were interested in conducting efficient searches but did not always know how. Therefore, either better training or better search interfaces are required to assist users and enable more effective searching.

Highlights

- Most searches of the Turning Research Into Practice (TRIP) database use only a single element of the clinical question, usually the population.
- The Boolean operators "AND" and "OR" are rarely used. Misspellings are common.
- Users like to have search results grouped into categories, separating guidelines from primary evidence. Among search results, familiar publications are preferentially viewed.

Implications

- Improving clinicians' access to electronic information will require clear, easy-to-use search functions that guide word combinations and/or better training in search techniques.
- Search engines should incorporate common misspellings.
- Helpful ordering and presentation of search results is likely to be of equal importance as the use of good search terms.

INTRODUCTION

Clinicians continually encounter clinical questions for which they need to find answers. For example, 350 million general practice National Health Service (United Kingdom) consultations per year take place [1], and, with a conservative estimate of one question per four primary care consultations [2], there could be at least 80 million consultation-related questions per year. Of the questions primary care physicians recognize, they have been shown to pursue only one-third [3].

Currently, real-time information needs in clinical care are often poorly addressed or ignored [4]. A consequence is that high-quality evidence is underused by clinicians to the detriment of patient care. Reflecting this issue, one study indicates that approximately half of recommended processes for health care are actually delivered to patients [5]. The causes of the gap between clinicians' information needs and meeting the needs include information overload (more than 1,800 research papers, including at least 55 randomized trials, are published per day), insufficient knowledge synthesis, and ineffective methods of continuing medical education [6, 7].

Though most health care workers would like to apply evidence more consistently, several practical barriers exist. These include failure to recognize or record important questions about patient care that arise in consultations and the lack of sufficient time, skills, knowledge, or confidence to search and appraise relevant research at the point of clinical decision making [8–10]. Therefore, better recognition of information needs and greater ease of access to evidence-based resources at the point of care is critical to the use of evidence in practice and improved care and outcomes for patients.

Table 1
Examples of resources in each Turning Research Into Practice (TRIP) database category

Category	Example content*
Evidence-based synopses	Bandolier, Evidence-Based Medicine, MeReC
Clinical questions	ATTRACT, National Library for Health Primary Care Question-Answering Service
Systematic reviews	Cochrane Database of Systematic Reviews, Swedish Council on Technology Assessment, Agency for Health Care Research and Quality: Evidence-Based Practice
Guidelines	National Guideline Clearing House (USA), Scottish Intercollegiate Guidelines Network (UK), Royal Colleges, PRODIGY (UK)
Electronic textbooks	eMedicine, GPnotebook
Clinical calculators	Clinical calculators
Medical images	Gray, Henry Anatomy of the Human Body, MDchoice.com
Patient information leaflets	Merck Manual: Home Edition, Prodigy Patient Information Leaflets
MEDLINE	PubMed via Clinical Queries

* Further information about the resources searched is available via the TRIP database [12].

Search and meta-search engines are now widely available and are designed to improve clinicians' access to available information. These engines allow clinicians to search several electronic evidence resources at once, the aim being to save time and enable more efficient searching of up-to-date information. A focused question is crucial to providing the evidence to facilitate change in practice [11]. The elements used in evidence-based question formulation are population, intervention, comparator, and outcome (PICO) [9]. Boolean operators such as "AND" and "OR" should be used to combine the PICO elements and increase the sensitivity (ORs) and specificity (ANDs) of a search.

The Turning Research Into Practice (TRIP) database—launched in 1997 as a result of the work of the founders, Jon Brassey and Chris Price—is a meta-search engine widely used in the United Kingdom and internationally [12]. The aim of the TRIP database is to allow easy access to online evidence-based material. Initially, the database was a collection of a few thousand links to various sites accessible via a crude search mechanism. Since then the site has developed into a sophisticated search tool, which now searches 150 resources (in addition to the millions of articles in MEDLINE) and over 80,000 documents such as guidelines and reviews. The TRIP database, which until September 2006 was subscription based, is now freely accessible.

The key features of the TRIP database can be subdivided into content and search technology. The content includes both primary and secondary research information categorized into: evidence-based synopses, clinical questions, systematic reviews, guidelines (for North America, Europe, or Other), electronic textbooks, clinical calculators, medical images, patient information leaflets, and MEDLINE. Examples of the resources in each category are shown in Table 1. A number of automated methods are used to improve the search recall and/or precision including the automatic addition of synonyms, Unified Medical Language System (UMLS) matching (using the UMLS metathesaurus), recognition of misspelling (which checks for misspellings when no results are found and suggests an alternative search term), and personalization (which restricts auto-searches to top journals in a specialty area) [13]. Further information about how the automated methods function can be found in the TRIP database [12].

Since the launch of the TRIP database, the majority of developments to improve the system have been devised "in-house" as a result of using the Website to provide the question-answering services ATTRACT (a service for Welsh General Practice) and the National Library for Health Question Answering Service (available to all). However, this study was commissioned to provide an independent external view of the TRIP database, by using individual user observation and Web log analysis conducted by persons not previously involved in the development of the TRIP database. The goals of the evaluation were to observe a number of individual users who were not associated with the database or the question-answering services and report perceived problems. The aim of the evaluation was to improve the system.

Analysis of Web log data from the TRIP database, supplemented by user observation, was used to address the main questions:
1. How do users currently search?
2. What problems do users have in finding appropriate answers to questions when using a meta-search engine?
3. How could the process or contents of the Website be modified to either improve the answers retrieved or reduce the time required to identify answers?

No studies have been identified that use an approach of similar mixed methods as in the current study, which used quantitative data from Web logs in combination with an observational study and subsequent analysis to identify how clinicians use a search engine in actual practice.

METHODS

The study was conducted in two phases: (1) a Web log analysis of the TRIP database and (2) an observational study of health care professionals' use of the TRIP database.

All search terms that appeared more than once in a year of Web log data from the TRIP database were analyzed, and an observational study focused on usability of the resources as employed by clinicians. The

combination of the two methods enabled the authors to study trends in and types of use and to identify and analyze specific problems encountered by the users.

Web log analysis

All user searches and links followed in the TRIP database between May 2004 and May 2005 were analyzed using Microsoft Excel. The data were sorted and a count of all unique terms or unique phrases made. The frequency of search terms and frequency of any Boolean operators (OR, AND, NOT) in search phrases were analyzed.

For searches on the most common topic (asthma), three authors (Glasziou, Heneghan, Brassey) independently classified the search terms based on the PICO structure [14]. Where authors did not agree, the final decision was made by the senior clinical author (Glasziou). Investigations were also conducted to determine which topics and resources were most frequently accessed. However, a limitation of the Web log is that the details of documents accessed via MEDLINE and medical images are not specifically recorded; therefore, if a user followed a link to MEDLINE or medical images, the Web log data does not indicate which document was retrieved.

User observation

To supplement the Web log information, a convenience sample of nine volunteers, all health care professionals, was observed while using the TRIP database. The study participants were from a range of health care disciplines and professions, the majority physicians, and were specifically chosen to provide a diverse user group. Participants were asked about their Internet use and previous use of the TRIP database. All participants had experience using the Internet, and two had used the TRIP database previously. These two users indicated considerable experience and training in evidence-based medicine (EBM).

The observational study was conducted by a researcher (Meats) experienced in EBM and familiar with, but independent of, the TRIP database. The observations lasted between thirty and ninety minutes and were conducted in a nonclinical setting in the United Kingdom between February and May 2005. The observer made written notes during the observational study, which were later checked against an audio recording for clarification. The observational study was semi-structured and based on two themes:
1. Method of question answering: the ways users formulate questions, the time taken to search, and the results categories used.
2. Investigation of various database features: exploring and commenting on the features found under each heading, such as clinical areas, my TRIP, publications, and about us.

To understand how clinicians approach a search, participants were asked to search for the answers to a question of their own and up to three predetermined questions from a selection of questions that had been asked by a general practitioner at the department of primary care within the previous few weeks. The predetermined questions were:
1. Are intermittent antifungals effective for onychomycosis?
2. Are there any effective treatments of molluscum contagiosum?
3. What are the symptoms of leptospirosis?

These three questions were chosen because they are about less common conditions seen in primary care. Participants were asked to continue to search until they found an answer that they felt confident about. When the question-answering task was complete, users were asked to navigate and comment on all sections of the Website. Participants were asked to think aloud throughout the entire observational study. The participants were observed as they used the TRIP database, and any questions, false tracks, or errors that occurred during the search were recorded by the observer and reviewed with the participant after the searches and navigation of the Website had been completed.

The observer prompted users to the next stage of the study, for example: "Now please can you look at and comment on the clinical areas section of the TRIP database." However, the observer did not answer questions or help the users in any way. Following the observations, participants were invited to comment on their searches and the meta-search engine. This report includes the information gained from the observations and the views of the nine participants. The observational data were analyzed thematically by the observer (Meats). The analysis involved coding, categorizing, and sorting the data to reveal emergent themes.

RESULTS

Web log analysis

Between May 2004 and May 2005, 620,735 searches were undertaken. Of these, 88% (n = 544,788) did not involve the use of Boolean operators. Approximately 11% of searches (n = 69,006) used the Boolean "AND," and only 0.8% (n = 4,941) used the Boolean "OR." Approximately 0.9% (n = 5,514) of searches used a multiline search and combined lines using terms such as "#1 AND #2." No terms were entered in 2,236 searches.

Most of the top 20 search terms indicated a disease, condition, or problem; fewer terms involved treatment, intervention, or diagnostic test (Table 2). The most common term was the single term "asthma," which accounted for just over 1% of all search terms. The highest ranking intervention was "hormone replacement therapy" at number 30, followed by "glucosamine" at number 47.

To analyze the types of multiword searches within topics, the searches used with the most common single topic "asthma" were studied (Table 3). "Asthma" occurred alone as a search term 4,952 times and occurred within a phrase an additional 2,513 times. Thus, a single term for asthma was about twice as common as a combined term, though the combined terms were rare-

Table 2
The most common search terms or phrases

Term or phrase	Frequency
Asthma	4,952
Diabetes	4,698
Hypertension	2,990
Cancer	2,718
Osteoporosis	2,404
Otitis media	1,937
Stroke	1,805
Breast cancer	1,672
Depression	1,643
Prostate cancer	1,445
Pneumonia	1,197
Obesity	1,176
#1 and #2	1,133
Copd	1,107
Atrial fibrillation	1,056
Pain	1,020
Heart failure	1,016
Migraine	1,006
Dementia	984
Pregnancy	966

ly connected by a specific Boolean operator. The most frequent combinations of terms were modifications or refinements of the population or problem such as "*childhood* asthma" and "*acute* asthma." Some users also added terms about an intervention (education, steroids, vaccines, etc). However, in the majority of searches, the PICO structure of question formulation was rarely used, and most questions consisted of only the population or the population and intervention elements, as illustrated in Table 3. Often multiple population elements were used. The comparator and out-

come were not used in this subset of searches. Columns 4, 5, and 6 indicate the number of results in the evidence-based, guidelines and question-answering service categories. The classification of the PICO elements of the search terms in Table 3 demonstrates that search terms that use the population element alone or multiple population elements appear to generate larger numbers of results than searches that use a combination of the population and intervention elements.

A number of searching errors were noted in the analysis. Misspellings were common, for example, hipertension (for hypertension) occurred 229 times and bronquiolitis (for bronchiolitis) occurred 167 times. The single most frequent misspelling was of the most common single term: "asma" (for asthma), which occurred 454 times. Some, but not all, of these errors were caught by the TRIP misspellings database. A second type of error involved ambiguity in use of Boolean operators, for example, the search phrase, "hrt or hormone replacement therapy" (which occurred 17 times in the Web log), is ambiguous. It can be phrased as either: "(hrt OR hormone) AND replacement AND therapy," which yields 2,465 articles in the Therapy filter of PubMed, or as "hrt OR (hormone AND replacement AND therapy)," which yields 5,182 articles in the Therapy filter of PubMed.

Resources used

For many of the 620,735 searches, the users only appeared to read the list of retrieved titles without viewing the resources to which the titles are linked. The

Table 3
Most common searches with the word "asthma"

Terms	Frequency	PICO* element	No. evidence-based results	No. guidelines results	No. query answering service results
Asthma	4,952	P	365	57	38
Asthma and children	134	P+	95	7	13
Asthma and child	79	P+	95	7	13
Asthma children	74	P+	95	7	13
Acute asthma	63	P	75	4	4
Asthma treatment	62	P, I	113	33	14
Childhood asthma	57	P+	95	7	13
Asthma*	52	P	365	57	38
Asthma and education	48	P, I	23	2	1
Steroids and asthma	48	P, I	19	0	5
Asthma and steroids	46	P, I	19	0	5
Asthma and child*	43	P+	95	7	13
Asthma management	38	P, I	113	33	14
Bronchial asthma	37	P+	79	10	23
Asthma and influenza vaccine	35	P, I	2	0	1
Asthma in children	32	P+	95	7	13
Asthma and childhood	32	P+	95	7	13
Asthma guidelines	31	P, E	2	12	1
Breastfeeding and asthma	31	P, I	2	1	0
Asthma and corticosteroids	30	P, I	43	1	3
Asthma* and "childhood asthma"	27	P+	15	1	0
Asthma steroids	27	P, I	19	0	5
Child* corticosteroids asthma	26	P+, I	4	1	1
Asthma education	25	P, I	23	2	1
Asthma and pregnancy	25	P+	0	3	1
Pediatric asthma	22	P+	95	7	13
Occupational asthma	22	P+	0	2	0
Influenza vaccination and asthma	22	P, I	3	0	1
Asthma child	22	P+	95	7	13

* P = population, I = intervention, C = comparator, O = outcome, E = type of document, + = more than one of that particular element.

Table 4
Number of followed links in the TRIP database (May 2004 to May 2005)

Source	Number of followed links	Type*
Database of Abstracts of Reviews of Effectiveness (DARE)	26,499	Systematic review
Cochrane Database of Systematic Reviews (Cochrane)	10,214	Systematic review
National Guideline Clearinghouse	15,070	Guideline
eMedicine	8,624	Textbook
BMJ Journals Online (EBM, EBN, EBMH, BMJ)†	7,492	Synopsis
ATTRACT	5,334	Synopsis
Bandolier	4,505	Synopsis
PRODIGY	3,909	Guideline
Clinical Evidence	3,532	Synopsis
General Practice Notebook	3,374	Textbook
National Institute for Health and Clinical Excellence (NICE), UK	2,330	Guideline
National electronic Library for Health (NeLH), UK	2,034	Guideline
Evidence-Based On-Call	2,007	Synopsis
The Journal of Family Practice Online	1,836	Synopsis
Evidence-Based Pediatrics Journal Club, University of Michigan	1,792	Synopsis
Merck Manual	1,576	Textbook
Best Evidence Topics (BestBETs)	1,521	Synopsis
National Health and Medical Research Council (NHMRC), Australia	1,510	Guideline
Swedish Council on Technology Assessment (SBU)	1,252	Textbook
Agency for Healthcare Research and Quality (AHRQ)	1,063	Guideline
National Coordinating Centre for Health Technology Assessment (NCCHTA)	1,062	Guideline
National Library for Health Primary Care Question Answering Service (Clinical Answers)	1,043	Synopsis
Total	107,579	

* The classification is based on Brian Haynes suggested "4S" typology [15].
† Evidence-Based Medicine (EBM), Evidence-Based Nursing (EBN), Evidence-Based Mental Health (EBMH), British Medical Journal (BMJ).

Web log showed that 131,740 searches resulted in accessing articles indexed in the TRIP database. The TRIP database Web log of linkages showed that around 20% of searches resulted in accessing externally indexed databases: around 10% (44,400) to MEDLINE and around 10% to medical images. Thus, the total number of links accessed was closer to 220,540 (i.e., 131,740 links followed directly from the TRIP database + 44,400 MEDLINE + 44,400 medical images). Therefore, on average, around one-third of all the 620,735 searches resulted in a user going to one of the documents retrieved by the search.

A wide range of resources was used. The most popular were the Database of Abstracts of Reviews of Effectiveness (DARE) and Cochrane Database of System-

atic Reviews (Cochrane) (Table 4). The 22 resources in Table 4 account for 82% (107,579/131,740) of all followed links, with the remainder from 121 other evidence resources searched by the TRIP database.

After analysis of the original Web log data, further data were collected about the top 10 articles viewed in the TRIP database during an entire year. The top 10 articles viewed during the year of 2005 and the number of times viewed can be seen in Table 5. Six of the top 10 articles viewed were guidelines, three systematic reviews, and one an evidence-based synopsis.

In addition, to find out more about the current users of the TRIP database, data were collected at the end of December 2005. The data revealed that users during the month of December were from: United States

Table 5
Top 10 articles viewed on TRIP database in the year of 2005

Title	Source	Number of times viewed
Geriatric care and treatment: a systematic compilation of existing scientific literature	The Swedish Council on Technology Assessment in Health Care [16]	490
National clinical guidelines for stroke	Royal College of Physicians [17]	221
Dyspepsia: managing dyspepsia in adults in primary care	National Institute for Health and Clinical Excellence [18]	196
Bisphosphonates (alendronate, etidronate, risedronate), selective oestrogen receptor modulators (raloxifene) and parathyroid hormone (teriparatide) for the secondary prevention of osteoporotic fragility fractures in postmenopausal women	National Institute for Health and Clinical Excellence [19]	147
Guidelines for management of hypertension: report of the fourth working party of the British Hypertension Society	British Hypertension Society Guidelines [20]	139
Routine antenatal care for healthy pregnant women	National Collaborating Centre for Women's and Children's Health [21]	133
High-risk and CHD Diagnosed	Health Evidence Bulletin—Wales [22]	129
Urinary tract infection in children	Clinical Evidence [23]	128
Acute pain management: scientific evidence	Australian and New Zealand College of Anaesthetists and Faculty of Pain Medicine [24]	125
Corticosteroids for Bell's palsy (idiopathic facial paralysis)	Cochrane Database of Systematic Reviews [25]	121

(69%), United Kingdom (10%), Canada (5%), Saudi Arabia (3.5%), and Spain (2.5%).

Usability testing: searching for answers

To complement the Web log analysis of user searches, a semi-structured observational study was conducted involving nine participants. Analysis of these observations revealed different approaches to the use of the TRIP database. For example, when searching for an answer to a clinical question, one participant looked in the clinical areas section of the TRIP database first, where resources are categorized into specific clinical subject areas, whereas others went straight to the general search function of the TRIP database.

Participants had many different approaches to formulating a search strategy, in particular whether to use single or multiple terms and whether to use Boolean operators. Most participants had questions about formulating a search and were interested to know whether Boolean operators could be used and in what format. The observer did not offer assistance at any stage. Those who used the search tip information in the search function found it to be useful, noting the advice on how to build a search and which Boolean operators were supported. Two participants who had considerable experience with EBM used the Boolean operators ''AND'' or ''OR'' or the truncation symbol ''*,'' alone or in combination, when searching, whereas most others used ''AND'' or did not use Boolean operators or truncation symbols. Participants often began, unsuccessfully, with complex searches and found later that they had more success searching with just one or two terms. The participants own questions included:

1. Should all type 2 diabetics be on aspirin?
2. What are the benefits and risks of surgical treatment for esophageal reflux in children?
3. Are topical antibiotics better than topical steroids for otitis externa?

The average time taken for participants to find satisfactory answers to clinical questions was 8 minutes (range 1.5 to 38), with satisfactory answers resulting from 74% (n = 14) of searches. Over half of these answers were found in 5 minutes or less. For the 26% (n = 5) of searches for which the participants failed to find satisfactory answers, the searches were abandoned after an average of 11 minutes (range 9 to 14). Of the 5 searches that were abandoned, 2 involved predetermined questions that other participants felt confident that they had answered, and the remaining 3 were the participants' own questions. After becoming familiar with the search function by searching for the answer to their initial question, most participants took less time to find answers to subsequent questions.

The observational study was semi-structured and therefore the observer would prompt the users as to the next task when necessary. Users were asked think aloud, and the observer did not prompt for questions; any questions that the participant had were noted by the observer and discussed after the observations were complete. Thematic analysis of think-aloud observations revealed that participants wanted to know about the methods by which the TRIP database searches and about the resources being searched. They were particularly interested to know about the background of resources they were not familiar with, for example, where they came from and how they were funded. Participants also wanted to know which countries particular guidelines applied to. They clearly preferred to look at publications from resources that they were familiar with rather than explore new resources, as evidenced by their choices and comments on encountering unfamiliar resources. Participants indicated that they liked the way in which results were grouped into categories and tended to choose evidence-based, query answering service, guidelines, and MEDLINE therapy articles in preference to other results categories.

Thematic analysis of the discussions subsequent to the searches revealed information about particular features of evidence-based search engines that participants found helpful. Access to a range of publication resources was appreciated, in particular access to medical images and patient information leaflets. In addition, participants found it helpful to have results grouped into categories separating guidelines and primary evidence.

The design and ease of navigation was also discussed. Participants indicated that it was important for Websites to use a color combination of text and background that is easy to read and for Websites to be easily navigated with clear and obvious links to the features. Many participants used the search tips linked to the TRIP database search function and would like the search engine to have quick reference guides linked to all areas of the database, for example, a quick reference guide to the clinical areas section of the TRIP database.

While formulating a search, participants liked to have the ability to add filters (e.g., restrict searches to core journals or article types) and be aware which filters, if any, have already been added. Participants also preferred to have the option of choosing either a simple or an advanced search. One participant suggested the advanced search could be set out in a PICO format.

DISCUSSION

The analysis of 12 months of Web logs found that most questions were formulated using just a single term that described the clinical condition. Only 1 in 9 searches used the Boolean operator ''AND,'' and only 1 in 125 employed ''OR.'' These results suggest that either search engine interfaces need a different approach to the way the interface is designed and the way it can be used and/or that clinicians require education about how to formulate a question and build up a search using appropriate terms.

The Web log analysis revealed that the most popular resources were the DARE and Cochrane databases. The systematic reviews in the DARE and Cochrane databases were used roughly in proportion to the numbers of reviews contained in each of the databases,

suggesting these were accessed by relevance of the review, not by which database the review appeared in.

The observational study gives several insights into how this search engine is used by health care professionals and the features they prefer. It is clear from the false tracks taken that more education or instruction is needed if users are to search efficiently. In addition, Web designers need to improve the clarity and ease of navigation of search functions, with clear information about resources searched. Better "tagging" of resources is also needed, including information about the country of origin, which is particularly important for guidelines. Participants suggested that the guidelines in the TRIP database should be grouped in this way.

In addition to obstacles due to Website design and layout, this study has also highlighted obstacles due to the methods by which users search. The findings of the current study reiterate obstacles found by previous studies, which include the time required to find information and difficulty in selecting an optimal search strategy [8]. The purpose of a meta-search engine is to simultaneously search multiple resources, allowing more comprehensive searching and saving time.

It has been found previously that time is a major barrier to general practitioners pursuing answers to clinical questions [10]. The need for improved information access including single portal access has also been highlighted [26]. Many of the obstacles found in the current study may also apply to other meta-search engines, and this study design involving both observational study and Web log analysis could also be applied other search engines.

No previous studies were found that used the combination of Web log data and observational study to address real user search behavior. However, one study reviewed relevant literature and existing information resources and used individual interviews and focus groups about current practice and information needs [26]. The findings were similar to the current study and suggested a need for improved information delivery systems based on user needs.

The current study has some limitations. Firstly, for the duration of the Web log data and the observational study, the database allowed three free searches per week, after which subscription was necessary (TRIP database is now free to all). This restriction might have affected the way in which the TRIP database was used. However, without having data about individual users' behavior, it was not possible to say whether this was the case. This restriction did not affect the observational study. Another limitation was that participants in the observational study did not use their own computers, and the presence of the observer and the artificial setting might have affected the participant's approach to the task. However, every effort was made to minimize the effect caused by the presence of the observer. In addition, this study was restricted to a single search engine. However, this is a meta-search engine containing most of the major evidence resources and is widely used.

Many of the conclusions drawn from this study are generalizable and useful to those involved in design-ing search engines and teaching search techniques. As a result of recommendations made by the current study, a number of changes have been made to the TRIP database. These include modifying the names of some of the categories in the TRIP database to add clarity and better understanding of the content. In addition, guidelines are now grouped into categories: North America, Europe, and Other. On the home page, there is a search function with a quick reference guide showing how to formulate a search. In addition, searches can be filtered by specialization, and clear explanation of how the TRIP database functions and conducts searches is provided. The patient information leaflets and medical images that were highlighted by the observational study as being a useful resource are now prominently linked from the home page.

This study has facilitated improvement of the TRIP database by identifying key aspects of search engine design: clear informative linking, a well-explained search function, and appropriate categorization of results. In addition, this study demonstrates that users appeared to make inefficient use of the search engine and the provided evidence resources. The study has found that users generally use simple approaches to searching, most use just the population element of the clinical question, and Boolean operators are rarely used. However, users are interested in learning how to conduct efficient searches. Hence, further research to understand how to provide simple but sufficient training in how to search or develop interfaces that encourage more sophisticated input could improve users' standards of searching.

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