

# Understanding the Potential for Collaborative Search Technologies in Clinical Settings

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## ABSTRACT

In this position paper, we report the findings of interviews with four medical doctors regarding the use of internet search by doctors and patients in support of the treatment process; we particularly focus on opportunities for collaboration between doctors and patients in clinical information retrieval scenarios.

**Keywords:** Collaborative search, collaborative information retrieval, health

## INTRODUCTION

In this workshop position paper, our goal is to identify a particular user group/scenario which may benefit from collaborative search technologies, and to identify important design considerations specific to this scenario. Specifically, we focus on the use of search technologies by doctors and patients in preparation for, during, and as follow-up to clinical appointments.

## Related Work

The intersection of healthcare and information retrieval is a topic that is beginning to receive attention from several perspectives. For example, Wilcox et al. have explored the appropriateness of Web content as a source of patient-friendly explanations for electronic medical record content [10], White and Horvitz have described how search engine logs reveal trends toward cyberchondria [9], and Schwarz and Morris developed visualizations to enable end-users to better assess the credibility of search results for critical topics such as healthcare [8].

The use of social search technologies in health scenarios is an active area of research; for instance, Paul and Dredze have examined how social media such as Twitter can be mined to reveal health trends [4]. Rather than *social search*, however, we focus specifically on *collaborative search* [3], in which participants actively work together to investigate a shared information need. A survey by Morris [2] found that family members researching a loved one's medical condition was a common motivation for engaging in collaborative Web search. Hertzum [1] and Reddy et al. [6, 7] have explored collaborative information practices in several healthcare scenarios; in this paper, we focus specifically on the current and potential collaborative search opportunities between patients and physicians surrounding clinical office visits.

## Interviews

To begin to understand current clinical Web search practices and potential opportunities for technology enhancements, we conducted interviews with four medical doctors in the Seattle metropolitan area in December 2009. Two of the doctors were hospitalists, the third specialized in internal medicine in a group practice, and the fourth was a family physician with a solo practice.

Interviews took place in person and lasted approximately one hour. Questions covered the nature of the doctors' and their patients' use of search technologies before, during, and after patient visits. Additional questions probed the doctors' perceptions of benefits, challenges, and desires surrounding the clinical search experience.

## CURRENT CLINICAL SEARCH PRACTICES

Search behaviors described by our interviewees fell into three main categories – actions taken before, during, and after a doctor's appointment. Note that for brevity we use the term "appointment" to refer to any encounter between the patient and doctor, such as an outpatient office visit or a visit to the Emergency Room.

## Before the Appointment

A patient searching the Web before a clinical visit was a relatively common phenomenon reported by all of our interviewees. The doctors in private practice reported that typically a couple of patients per day discussed the findings of a health-related Web search during their visit. The hospitalists reported encountering Emergency Room patients who discussed prior Web search findings a few times a week.

The doctors noted that patients who conducted pre-appointment Web searches tended to be younger and more affluent than those who did not. Patients with chronic, rather than acute, conditions were more likely to have engaged in prior Web research; one doctor estimated that between 1/3 and 2/3 of his patients with chronic health conditions had done pre-visit searches.

Patients typically communicated their search findings either verbally or by bringing printed copies of relevant Web pages. The doctors estimated that they encountered a patient bringing printed Web pages about once per week. Examples of printouts brought to appointments include printing news articles describing medical conditions patients thought they should be tested for and printing pages from

pharmaceutical companies' websites describing medications patients wanted to try. None of the doctors reported encountering patients using devices such as mobile phones, tablets, or laptops to share a live Web page.

### **During the Appointment**

#### ***Patients***

The doctors in private practice did not encounter patients conducting searches during appointments. However, the hospitalists reported patient use of search technology during hospital visits.

Searching while in the Emergency Room was rare, although one doctor reported that family members accompanying patients in the ER sometimes conducted searches; for example, he recalled an instance when a family member waiting with a stroke victim used a laptop to research whether the hospital and doctors had special certifications for dealing with strokes.

The hospitalists estimated that as many as 20% of the patients admitted to the hospital had laptops with them and searched for information online during their stay (both hospitalists worked at hospitals that had free hospital-wide wireless internet connections available to patients). Common topics for in-hospital searches include information about the diagnosed condition and information about drugs prescribed as treatments, such as about potential interactions between newly prescribed drugs and other medications the patient may be taking.

#### ***Doctors***

The hospitalists we interviewed noted that they carry laptops with them while doing rounds, but only rarely have used them to conduct searches in a patient's presence; rather, they mostly use the laptops for personal reference or to share medical images (such as X-ray images) with a patient.

Both private practice doctors, however, indicated that conducting a search during an appointment was not uncommon for them; the family physician used a laptop to conduct searches during appointments about once per day, while the internist used PCs installed in exam rooms to conduct searches about once a week. The doctors indicated using their computers to search over both specialized medical databases as well as the general Web.

***Specialized Searches:*** Subscription services such as UpToDate [www.uptodate.com] and free services such as E-medicine [www.e-medicine.com] were searched to access research literature and diagnostic information on less familiar patient conditions, and to access patient-friendly descriptions of such conditions, which the doctors then printed and gave to patients to take home with them. The doctors also searched the websites of other hospitals and medical facilities in the region to obtain contact info and transportation directions for specialists whom they were referring their patients to, and then printed this information so that patients could take it home.

***General Web Searches:*** The doctors also described several scenarios in which they used general-purpose search engines (usually Google) during a patient appointment. These searches were of several types: researching a condition or treatment, explaining a condition or treatment, persuasion, and social.

***Researching a Condition or Treatment:*** The doctors described several scenarios in which they used Web search while in the room with a patient in order to research a treatment or condition. For example, many patients attempt to treat themselves with "natural" or "alternative" products that the doctors were not familiar with – the doctors used Web search to learn about what ingredients were in these products and whether they were safe for patients to continue using. One doctor mentioned that Google's Image Search feature was useful in diagnosing rashes – she would search for the names of several different rash types and compare the images to the patient's rash. She noted that this method was preferable to using a reference book since the reference books typically contained only a couple of pictures of each rash, whereas the Web search returned a much larger sample set that would better account for variations she might see.

***Explaining a Condition or Treatment:*** The doctors also described conducting searches to find materials to show patients in order to clarify or explain a diagnosis. For example, one doctor mentioned that he used Google Image Search to find diagrams of knee anatomy in order to better explain to a patient the nature of a certain knee injury. Another doctor described searching for YouTube videos in order to show a patient how to perform the "Epley's Maneuver"; she noted that although her official medical reference books contained diagrams of the maneuver, the online videos were easier for patients to understand.

***Persuasion:*** The doctors also described scenarios in which they conducted searches with patients in order to persuade a patient that a particular diagnosis or treatment was appropriate, in a sense using the search to provide a "second opinion." For instance, when one of the doctors told a patient with the H1N1 flu that no medication was necessary, the patient demanded the medicine TamiFlu since she had heard it mentioned on a news report, so the doctor used the CDC website to show the patient that the official government recommendation was that most people not be given this medication. Another doctor described trying to persuade patients to quit smoking by showing them Web pages that calculated statistics such as their "lung age."

***Social:*** The family physician mentioned that he also conducted searches with patients about topics other than their immediate medical issues, as part of his "treat the whole patient" philosophy. For example, if a patient was unemployed, he might search online for relevant volunteer work opportunities and share them with the patient. One of the hospitalists mentioned that he will search for online support groups for particular illnesses and share these with patients.

### After the Appointment

Doctors mentioned using search, typically over proprietary systems such as UpToDate, E-Medicine, or PubMed, to learn more about unusual symptoms or diagnoses. The family physician in a solo practice mentioned that he also uses a feature of the eClinicalWorks EMR (Electronic Medical Record) system that enables all of the physicians who use that EMR software to communicate with each other, in a manner similar to an electronic bulletin board. He described using this feature on particularly tricky cases, in order to see if other doctors had ideas about appropriate diagnoses or treatments – as a solo practitioner, he particularly valued the opportunity this software offered him to ask questions of other doctors virtually.

Doctors described giving patients “homework” or “prescriptions” for Web sites to read and Web searches to conduct after appointments. The main purposes of after-the-appointment Web use was for either additional patient education or for self-monitoring.

**Patient Education:** One doctor mentioned that about once a day she recommends a patient do additional reading after a visit, and uses her prescription pad to write down the URLs of trusted websites followed by the names of the links the patient should click or the words that the patients should enter into the search box on that trusted site (e.g., go to “cdc.gov” and type “H1N1” in the search box).

**Self-Monitoring:** One doctor mentioned that he often recommends specific Web sites that might help patients achieve their health goals, such as to have patients with special dietary concerns use the site “Fit Day,” which is a free site that helps them track what they have eaten. Another doctor described how for non-urgent conditions with symptom-based (rather than test-based) diagnoses, such as Parkinson’s Disease, she would refer them to Web pages with lists of symptoms so that the patients could track which symptoms they did and did not experience when trying new medications or therapies.

### CLINICAL COLLABORATIVE SEARCH

The aforementioned uses of Web search by patients and doctors before, during, and after appointments suggest opportunities for designing technologies to better support multi-party clinical Web searches. When designing such technologies, in addition to considering the use scenarios described above, it may also be beneficial to reflect on the strengths and weaknesses of these status quo clinical search strategies; the remainder of this section reports on doctors’ impressions of the current benefits and challenges of clinical Web search.

#### Benefits

Three main benefits of clinical Web search emerged in our discussions with physicians: convenient and diverse information access, patient reassurance, and self-care support.

**Convenient and Diverse Access:** Doctors found that using Web search rather than reference books to gather information and answer questions during patient visits was advantageous because of the breadth of information available

– using a laptop enabled access to many types of diagnostic sources, whereas finding the correct reference book often required leaving the exam room, and the internet often contained more examples than books. For example, one doctor noted that Google Image Search turned up hundreds of examples of a particular type of rash whereas her reference book contained only two, and that viewing more examples helped give her a better impression of the types of variations that she might look for.

**Patient Reassurance:** Doctors felt that, when guided to approved sites, patients could receive important reassurance from the Web, such as by viewing pages during office visits that echoed doctors’ suggestions (providing a virtual second opinion) or by viewing pages after an office visit that the doctor “prescribed” for follow-up education.

**Self-Care Support:** Doctors described the beneficial use of vetted websites for patient self-care post-exam, such as for dietary tracking or symptom monitoring. They also noted that occasionally pre-appointment research by patients resulted in improved medical outcomes, such as by suggesting diagnosis or treatment options that the doctor had not considered (although they noted that this was an atypical occurrence).

#### Challenges

Although clinical Web search offers benefits, our interviewees identified several problems with the status quo use of search by doctors and patients. These challenges include anxiety, fixation, credibility, perceptions, integration, and follow-up.

**Anxiety:** All of the physicians we interviewed noted that pre-appointment searches often increased patients’ anxiety, generally without cause, due to phenomena such as cyberchondria [9] in which search results for medical symptoms tend to disproportionately return serious but unlikely diagnoses. For instance, one doctor described a case where a patient experiencing tingling in the extremities, which can signify a number of relatively benign conditions, became convinced after conducting a Web search on that symptom that it might be due to HIV infection.

**Fixation:** In addition to increasing patient anxiety, searches conducted as preparation for an appointment can also cause what one doctor described as “fixation” on an inappropriate diagnosis or treatment. This creates physician frustration by requiring them to devote a great deal of time to explaining why the information the patient found is irrelevant, and to dissuading patients from following improper courses of treatment.

**Credibility:** Doctors were concerned with the quality of health information available online, which is why they always gave patients specific suggestions of sites to view or even provided hard-copy printouts of information. However, even doctors themselves have uncertainties about identifying credible health sites. For example, one doctor mentioned a list of sites she recommended as patient resources, but then also noted that she thought other doctors in her

practice preferred different sites, and that it seemed as if each doctor had their own “ad hoc” list and that each was probably unaware of some potentially valuable sites. Another doctor mentioned that he cautions patients to only view “reputable” sites, but that he has trouble giving them an operational definition of how to determine which sites meet this standard.

**Perceptions:** Although physicians found it useful to consult external sources, such as the Web, when they were unsure of something, they were concerned that patients sometimes viewed their use of reference materials (even traditional ones) as a sign of deficient expertise. For example, one physician reported that after she consulted a reference book during a patient appointment, the patient switched her care to a colleague because she did not feel the original doctor was confident enough. Such concerns may prevent doctors from utilizing search resources during patient appointments.

**Integration:** Doctors sometimes had to repeat the same searches many times in order to target a variety of proprietary and general-purpose systems, such as issuing the same search to UpToDate, PubMed, and Google. In addition to a lack of integration of search targets, another opportunity for a more cohesive search experience lies in electronic medical records (EMRs), which are being increasingly adopted by medical providers. These EMRs remain completely separate from the Web search experience; however, personalizing medical searches based on information contained in EMRs could be a valuable way to improve result relevance, though this could bring up additional challenges relating to the security of patient records.

**Follow-Up:** Several doctors described the practice of “prescribing” websites and searches to patients to promote education, reassurance, and self-care. However, the doctors also mentioned that they unfortunately had no way of knowing whether patients viewed or used the suggested sites.

## **DESIGN CONSIDERATIONS**

Based on our interviewees’ reports of how they and their patients use search before, during, and after appointments and on what they see as the benefits and challenges of these clinical search incidents, we propose several design recommendations for the design of collaborative clinical search technologies. The four key design considerations we have identified are the need to support diversity in searcher roles, information sources, search phases, and hardware.

### **Supporting Distinct Roles**

Supporting distinct roles for the doctor and patient will be crucial for the success of any collaborative clinical search system. Pickens et al. [5] first proposed distinct user roles in collaborative search; here, we identify how roles can be employed specifically for clinical scenarios.

For example, queries issued by doctors might retrieve results from a larger set of sources than patients’ queries (such as proprietary systems owned by their institution). Even over an information source available to both doctors

and patients, such as the general Web, results provided to doctors and to patients might differ such that articles with more advanced terminology are shown only to doctors (or perhaps such technology can be automatically simplified for patient consumption [10]). Patients’ results for a given query might also be customized based on their medical history, such as through integration with data from their EMR. Doctors may be able to mark certain sites or pages as credible or not credible (or such ratings may occur implicitly, based on one or more doctors’ clickthrough and browsing patterns [8]).

Privacy is also a consideration in such a system, and the ability for patients to choose what subset of their search activity to reveal to the doctor (and vice-versa) may be important.

In addition to providing roles for the doctor and her patient, a collaborative clinical search system might also benefit from offering roles for a patient’s family members or for additional doctors beyond the primary physician (such as consulting specialists).

### **Supporting Multiple Sources**

Doctors identified a number of information sources that may be valuable to integrate into a single clinical search system. These sources include general-purpose Web search engines, multimedia searches, vertical searches on trusted health sites, and searches of proprietary and/or subscription medical information services. Developing algorithms to intelligently create result sets from queries federated to these disparate sources is an interesting area for innovation.

### **Supporting Search Stages**

Our interviewees identified three main stages of clinical search – before, during, and after an appointment. System designers have an opportunity to provide a more fluid and integrated experience across these three stages. For example, it might be beneficial for a doctor to be able to view a summary of the patients’ health-related queries before an appointment begins, or to view the live versions of the relevant Web pages a patient uncovered (rather than the patients’ verbal recollections of what was on those pages, or outdated static printouts).

The after-appointment experience can also be enhanced. Doctors currently print out information sheets for patients to take home or write URLs and search terms on a prescription pad, but they could instead use a collaborative search system to make send live links and pages to their patients. Such a system could also provide an audit trail that enables the doctor to see whether a patient has actually accessed recommended educational and self-care sites (and perhaps also audit the time a doctor spends interacting with a patient on search for billing purposes).

### **Supporting Diverse Hardware**

Doctors and patients use a variety of technologies to conduct searches, including PCs, laptops, and mobile phones (and perhaps specialized exam-room displays [10]). Successful clinical collaborative search tools will need to store data securely in the cloud to enable cross-device access, as

well as providing device-appropriate user interface adaptations.

## CONCLUSION

In this paper we reported the findings of interviews with four medical doctors regarding how they and their patients use search in support of clinical encounters. Because the doctor and patient share the goal of diagnosing and treating the patient's health issues, we consider these practices to be a form of collaborative search [3], albeit one that is not well-supported by current technologies. Based on doctors' descriptions of status quo clinical search practices and their benefits and drawbacks, we identified design guidelines for successful clinical collaborative search systems. We hope to discuss these ideas with other participants at the CIKM Collaborative Information Retrieval Workshop.

## REFERENCES

1. Hertzum, M. Breakdowns in Collaborative Information Seeking: A Study of the Medication Process. *Information Processing and Management*, 2010.
2. Morris, M.R. A Survey of Collaborative Web Search Practices. *CHI 2008*.
3. Morris, M.R. and Teevan, J. Collaborative Web Search: Who, What, Where, When, and Why? *Morgan & Claypool*, 2010.
4. Paul, M. and Dredze, M. You Are What You Tweet: Analyzing Twitter for Public Health. *ICWSM 2011*.
5. Pickens, J., Golovchinsky, G., Shah, C., Qvarfordt, P., and Back, M. Algorithmic Medication for Collaborative Exploratory Search. *SIGIR 2008*.
6. Reddy, M. and Jansen, J. A Model for Understanding Collaborative Information Behavior in Context: A Study of Two Healthcare Teams. *Information Processing and Management*, 44(1), 2008.
7. Reddy, M. and Spence, P.R. Collaborative Information Seeking: A Field Study of a Multidisciplinary Patient Care Team. *Information Processing and Management*, 44(1), 2008.
8. Schwarz, J. and Morris, M.R. Augmenting Web Pages and Search Results to Support Credibility Assessment. *CHI 2011*.
9. White, R. and Horvitz, E. Cyberchondria: Studies of the Escalation of Medical Concerns in Web Search. *ACM Transactions on Information Systems*, 27(4), 2009.
10. Wilcox, L., Morris, D., Tan, D., Gatewood, J., and Horvitz, E. Characterizing Patient-Friendly "Micro-Explanations" of Medical Events. *CHI 2011*.