Construction and Feedback of an Information System by Analyzing Physicians' Information-Seeking Behavior

의사들의 정보추구행태를 반영한 의학정보시스템 개발 및 평가

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ABSTRACT

Physicians have information needs related to academic research and clinical practice but encounter difficulties seeking appropriate medical resources and information. The goal of this study is to develop a search system to support Korean physicians' information needs. To access sources to meet the identified need, in-depth interviews were conducted, and MediSearching, a new search system, was developed accordingly. To verify its usefulness and to obtain users' suggestions, interviews were conducted and feedback was solicited via collected test searches. The initial set of interviews indicated that physicians' information needs and search behaviors differed by type of hospital and clinical department. Physicians in university hospitals with a greater need for research materials searched for academic articles, whereas physicians in specialty hospitals or primary care clinics with a stronger need for materials related to clinical practice asked their colleagues for information. Consequently, MediSearching was designed to satisfy both groups' needs, and the test search provided useful search results compared with existing services. Korean physicians have previously had to repeat their search process on separate sites that provide different services according to type of information and search method. MediSearching may reduce this inconvenience and add documents in various formats and languages.

초 록

의사들은 학술연구와 환자진료에 관한 정보요구를 가지고 있고, 전자정보원을 이용하여 해결하고 있으나 정보원의 선택이나 검색에서 어려움을 겪는다. 본 연구는 의사들의 연구와 진료정보요구를 지원할 수 있는 검색시스템을 설계하고 개발하는 것이 목적이다. 이를 위해 의사들의 정보요구에 적합한 정보원 개발을 위해서 정보이용행태에 관하여 심층 인터뷰를 하였고, 그 결과를 바탕으로 검색 시스템인 MediSearching을 개발하였다. 개발된 시스템은 효용성 검증과 제안을 얻기 위해 추가 인터뷰와 테스트검색을 통하여 피드백을 받았다. 의사들의 정보이용행태에 관한 인터뷰 결과 소속병원의 종류나 진료 과목에 따라서 차이를 보였다. 대학병원 의사들은 연구와 관련된 정보요구가 컸으며 학술지 논문을 주로 이용하고 있었으나, 전문병원이나 개인병원 의사들은 진료와 관련된 정보요구가 대부분으로 동료와의 대화로 해결하는 형태를 보였다. MediSearching은 연구와 진료정보요구를 동시에 지원할 수 있는 검색시스템으로 개발되었고, 인터페이스와 검색효용성이 검증되었다. 기존의 한국 의학 정보 사이트에서는 제공 정보의 종류나 검색 방법에 따라 서비스 범위가 모두 달라 의사들은 동일한 검색 과정을 반복하는 불편함이 있었으나 이를 해결한 것으로 파악되었다. 또한 파일 형태나 언어와 상관없이 정보원의 추가가 가능하도록 한 점에서 유용한 것으로 평가되었다.

Keywords: information-seeking behavior, information services, practice guidelines, evidence-based practice, medical information system
의사들의 정보이용행태, 정보서비스, 진료지침, 근거중심의학, 의학정보시스템

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1. Introduction

The electronic information environment based on computers and communication techniques has affected all of society, academic research and lifestyles. Researchers seek information from electronic resources, and physicians—the subjects of this study—are no exception. Thanks to the use of the Internet in daily life and for academic purposes, much information can be obtained simply and easily; however, obtaining information that meets a user's needs becomes more difficult. Thus, it is critical to address information needs quickly. Although researchers can access information relatively easily regardless of their location because of the expansion of electronic sources, some researchers experience difficulties in utilizing electronic devices. According to a study by Davies and Harrison on obtacles faced by physicians when searching medical literature, online or IT-related sources are high on the list of access problems, and two-thirds of the subjects noteda lack of time and a limited search ability (Davies & Harrison, 2007). Therefore, a guide to electronic sources for studies is an important library service.

Medicine, a field of primary interest to the subjects of this study, is the science and practice of the diagnosis, treatment, and prevention of disease (Oxford Dictionaries Online, 2014) and is an essential study that affects our lives directly and indirectly. Thus, an encompassing support system to fulfill physicians' information needs is necessary, and efforts to understand their information needs accurately and providing a search service satisfying those needs should be a priority. However, most studies on information needs, information use patterns and information sources have been conducted with primary care doctors as subjects, and particularly in South Korea, only a few studies have been conducted with physicians as subjects. Most studies on medical information sources have utilized PubMed (Herskovic, Tanaka, Hersh, & Bernstam, 2007; Lu & Wilbur, 2009; Markey, 2007; Tang, 2007). Because evidence-based medical sources and their services are currently increasing, some studies on the present status of the utilization of these sources and news articles on the necessity of a national-level information system have been reported in South Korea (Ministry of Health & Welfare and Korean Academy of Medical Sciences, 2009, 2012). Therefore, analysis of and suggestions regarding contents and search services to establish local evidence-based medical sources are required in addition to studies on their necessity and feasibility.

This study has two objectives: to investigate physicians' information needs and information-seeking behavior and to develop a practical search system that satisfies physicians' information needs in order to minimize their difficulties when searching for medical information by investigating their needs and information-seeking behaviors.

2. Literature Review

As shown in Leckie's model, non-medical professionals seek information related to their occupational roles or jobs, and physicians search for in-

formation regarding their jobs as well (Leckie, Pettigrew, & Sylvain, 1996). This model intentionally limited the range of subjects to experts such as physicians, lawyers and engineers and explained their occupational roles and important job-related factors. Kostagiolas, et al. (2015) observed that doctors seek information on the Internet to address their work-related information needsAuthor Vitae. According to other studies analyzing 34 papers regarding the information-seeking behaviors of physicians published from 1996-2006, over 90% of the papers accessed addressed the information needs of clinical practice such as diagnosis, treatment/therapy and drugs, and over 60% searched for simple information (Davies & Harrison, 2007). However, most subjects of existing studies were primary care and family physicians, and it was difficult to identify a study investigating overall medical institutions.

Physicians want to handle their work-related problems by searching for information using search systems; however, physicians encounter difficulties checking, evaluating, and applying an enormous number of search results in the process. One study compared the explosive increase in medical information to a tsunami (Slawson, Shaughnessy, & Bennett, 1994). Many studies have noted a lack of time as one of the greatest challenges for physicians who must cope with so much information (Fenton & Badgett, 2007; Fourie, 2009; Revere & Fuller, 2008) whereas other studies have emphasized the importance of information-search skills, noting that many physicians access out-of-date or inaccurate information; physicians must treat patients using data gleaned from approximately 2 million pieces of information accumulated over 5,000 years (Smith, 1996). Studies on how physicians have handled their information needs have concluded that physicians are excessively confident in their retrieval ability, make emotional decisions when selecting sources and information, and fail to appropriately explain their information needs (Kules & Shneiderman, 2008). Physicians also used elementary sources (Hersh et al., 2002), and the majority sought information in a simple manner using a single search word (Herskovic et al., 2007). They tended to prefer well-known or reliable sites (Hughes, Wareham, & Joshi, 2010) and were fully satisfied only when they searched for information on academically prestigious sites (Kourouthanassis, et al., 2015). These findings are not significantly different from the findings of studies performed with Korean physicians. One study concluded that Korean physicians have significant information needs; Korean physicians are required to discern recent research trends in their areas of expertise and gain clinical experience (Hong, 2008). Another study, whose participants were primarily physicians in university hospitals, reported that the need for academic research was greater than the need for clinical experience and that physicians primarily used current articles in journals (Kim & Park, 2009). A representative source for addressing information needs is PubMed (PubMed.com, 2015) and many studies have been conducted regarding this source. Google, a worldwide search engine, has also been considered a useful source (Tang & Ng, 2006) whereas evidence-based medicine (EBM) sources are considered helpful for

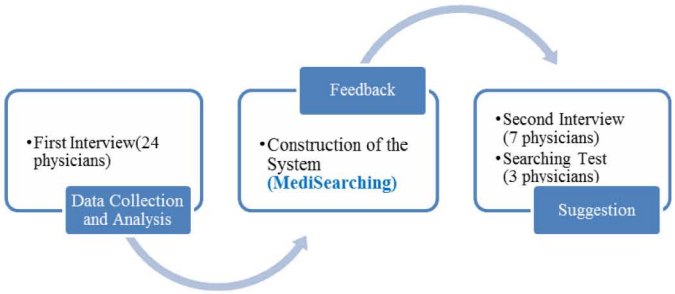
clinical issues and have been utilized increasingly more often (Fourie, 2009; McKibbon, Fridsma, & Crowley, 2007). Although Korean physicians recognized the need for these various sources, their utility rate of EBM sources tended to be low because of the lack of sources (Ministry of Health & Welfare and Korean Academy of Medical Sciences, 2009; Park, 2000a). As EBM sources for physicians, clinical guidelines obtained without charge can be an alternative. Even primary care physicians can use the guidelines produced and distributed by specialists in academic societies. The United States (National Guideline Clearinghouse: NGC), England (Scottish Intercollegiate Guidelines Network: SIGN), and Australia representatively offer national-level services of clinical guidelines. In Korea, the Ministry of Health and Welfare financially supports KGC (KGC, 2015) and KoMgI (KoMgI, 2015); however, their efficiency and usage are relatively low because these services contain only a small number of guidelines and users can search only for titles or subtitles. Park noted the necessity of EBM education for primary care doctors and physicians in large hospitals. Park's study indicated that most clinical studies were conducted in university hospitals so that it was difficult to apply their results directly to primary care situations. Thus, the study insisted that clinical studies focusing on local communities should be the purview of primary care physicians and that the primary care physicians should be familiar with the latest medical information (Park, 2000b).

3. Methods

This study includes two sets of interviews with physicians in university hospitals, specialty hospitals, and primary care clinics, the development of a search system, and the compilation of feedback from a test search. These interviews were conducted and feedback was compiled from November 2011 to October 2013. MediSearching, medical information system, was developed in April 2012. The process is presented in <Figure 1>.

3.1 Information-seeking behaviors of Korean physicians

The first in-depth interviews (with 24 interviewees)



〈Figure 1〉 Methods

〈Table 1〉 Questions for first interview

Category	Questions	Related Study
Information needs and information-seeking behavior	Types of information needs, types of sources used, information-searching process, satisfaction with search results	Kostagiolas et al., 2015; Hughes et al., 2010; Hong, 2008; Han & Lee, 2006; Kim & Park, 2009
Type of research	Types of ongoing research (experimental/clinical, single/collaborative), satisfaction and dissatisfaction with the research process	Han and Lee, 2006; Kim & Park, 2009
Preference for medical information source	Types of preferred sources, standards for choosing a source	Kourouthanassis et al., 2015; Hughes et al., 2010
Use of EBM source and suggestions	Use of EBM source, usefulness of clinical guidelines, opinions and suggestions for using EBM source more actively	McKibbon et al., 2007; Park, 2000a

regarding their information needs, information-seeking behaviors, characteristics, changes in medical information sources and the characteristics of medical information source services were conducted to determine participants' information needs. The interviews comprised semi-structured open questions to obtain various opinions; the interviews averaged one hour.

Based on the assumption that the physicians' information needs and information-seeking behaviors would differ according to the types of hospitals in which they worked and their departments and clinical experiences, the subjects were divided into physicians in university hospitals, specialty hospitals, and primary care clinics. Finally, 24 interviewees were chosen according to their departments. The participants included 17 males and 7 females; 4 were in their 50s, 40s and 10 were in their 30s. Participants' departments included family medicine, internal medicine, anesthesiology, obstetrics and gynecology, pediatrics, ophthalmology, radiology, surgery, otorhinolaryngology, rehabilitation, orthopedic surgery, dentistry, and dermatology. Interview questions were largely classified into four categories. The differences by types of medical institutions and departments in the clinical sector were examined.

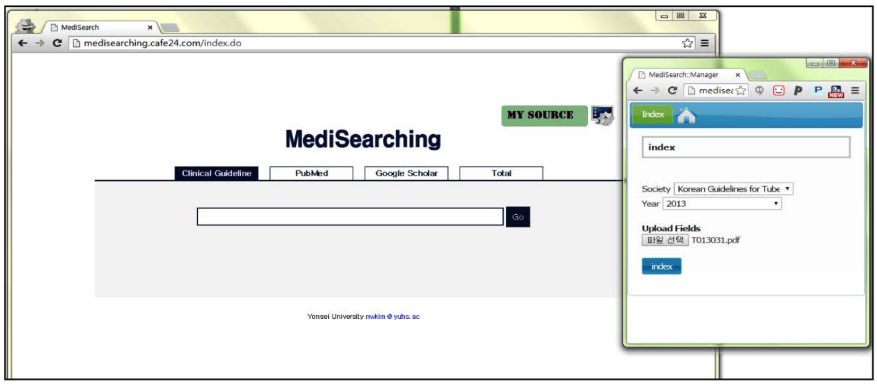
The questions referred to previous studies investigating doctors' information needs, information-seeking behavior, type of research, preference for medical information source and use of EBM source. The contents and the studies are presented in <Table 1>.

3.2 Development of a search system

Based on the results from the first interview, the MediSearching search system was developed to support physicians' information needs. Its main page shows a single search bar and five menu items—Clinical Guidelines, PubMed, Google Scholar, Total, and MySource—based on those sources physicians preferred and utilized frequently(<Figure 2>). PubMed and Google Scholar were chosen because of their high frequency of use; clinical guidelines were also added. As clinical guidelines are updated

and developed, the menu could add additional guidelines or include guidelines from other countries for searches by re-indexing all guidelines.

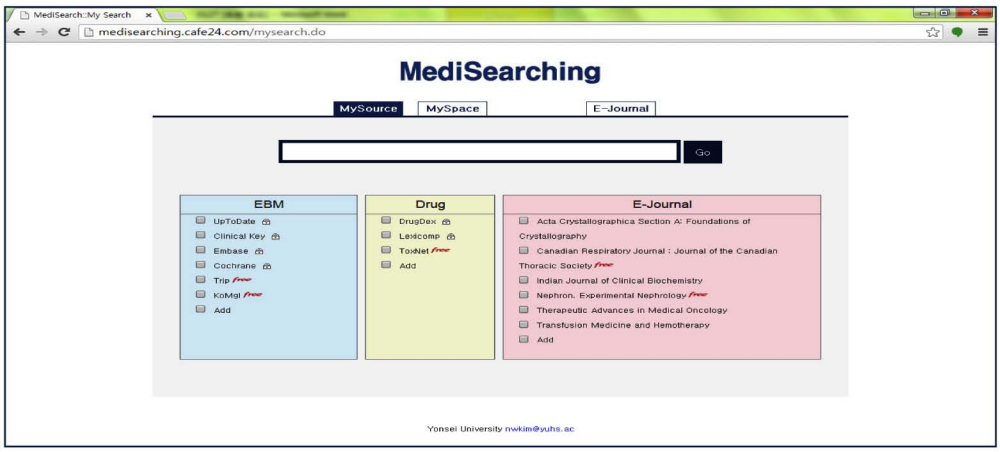
In particular, the Clinical Guidelines menu was developed using Lucene, an open source for the automatic indexing of original texts in various file formats (e.g., txt, doc, html, pdf) after collecting the guidelines from other sites using a web crawler. Considering that there is no Korean site that can search both full texts and names of clinical guidelines, Clinical Guidelines is the most important menu option in MediSearching. This menu was designed based on requirements obtained during the first interviews. <Table 2> details the requirements and resulting development.



〈Figure 2〉 MediSearching main page

〈Table 2〉 System requirements and development

	Requirements	Development
Data	Collect clinical guidelines from many services and then make them available through one service.	Using a web crawler, clinical guidelines were collected from various services.
	Different types of clinical guidelines should be made available in one location.	Collected from a variety of formats of clinical guideline files (pdf, Microsoft Word, text, html)
Indexing	Diseases, treatment, and titles of guidelines should be searchable by keyword.	Lucene, an automatic indexing program, indexed titles, keywords of the guidelines, and full text.
	Primary keywords as well as names of societies and copyright dates should be searchable.	Indexing using the CJK analyzer to ensure accurate search results in Korean texts.
		Names of societies and copyright years are built into the meta data.
Searching	Search accuracy is important when using clinical guidelines.	The same CJK analyzer should be used to parse queries to enable accurate searching of the Korean texts.
		The search results should be based on VSM and BM algorithms to show the search results by similarities between queries and primary contents.
Result Display	The names of the societies responsible for the clinical guidelines and copyright dates should appear as a component of the search results without having to browse the entire guideline.	The names of societies and copyright dates should appear prominently in the search results.



〈Figure 3〉 MySource Menu

In addition, MySource was presented as a map of frequently used sources. The sources were largely divided into EBM, Drug, and E-Journal. Sources by categories were recommended, and users could register some of the sources to their MySpace menu for use. This menu was developed by considering the interview results indicating that participants had difficulty obtaining information on certain types of sources(<Figure 3>).

3.3 Usefulness of MediSearching

The usability assessment of MediSearching was conducted by applying Scott and Norman's effectiveness measures of an information system. Those authors suggested four categories for the evaluation: definition of a system, performance assessment, process of MIS (Management information system), and viewpoint account. This study adopted the performance assessment and viewpoint account from the four categories to investigate the usefulness and the relevance judgment of MediSearching.

Interviews regarding usefulness were conducted with seven physicians (one in anesthesiology, one in dermatology, one in ophthalmology, one in otolaryngology, two in pediatrics, one in surgery) who had participated in the first interview and had extensive search experience. By referring to a study evaluating the quality of interface with 21 websites specializing in Korean research information, the questions of the interview comprised four categories in <Table 3>. The interviewees searched for information related to their own specialty to answer each question. As they had no experience with online searches for clinical guidelines, they were instructed to conduct the same search process using existing Korean sites, KGC and KoMgI, and then compare the results with the results of MediSearching. Their opinions and suggestions regarding the process and the results were described using the Think Aloud method.

〈Table 3〉 Questions for second interview

Category	Questions	Related Study
Construction of main page	Overall opinion regarding interface Adequacy of arrangement of search box and menus	Choe et al., 2001; Haines et al., 2010; Ketchell et al., 2005; Kules & Shneiderman, 2008
Characteristics of search menu	Preference for and satisfaction with the composition of each menu	
Display in search results	Satisfaction with filtering options and search results	
My Source	Adequacy of screen composition and selected sources	

Five physicians participated in the first interviews, and their answers were analyzed. The analysis concluded that their opinions were similar to one another regarding MediSearching's usefulness, necessity, menu composition, and key words. Two additional physicians were interviewed, and their comments were consistent with the answers of the previous five interviewees. Thus, the interviews to assess the usefulness of MediSearching were concluded with seven interviewees.

Next, the relevance of the search results in the Clinical Guidelines menu was assessed. The tests were conducted by physicians in family medicine and pediatrics, who often utilized clinical guidelines. Thirty clinical terms were selected as search words by keeping top search words in NGC (National Guideline Clearinghouse), an American site on clinical guidelines. The participants searched the same words via MediSearching, KGC, KoMgI and PubMed, which all provide search service for clinical guidelines, and then compared their results. The physicians' degree of satisfaction was recorded.

4. Results

4.1 The physicians' opinions and comments of medical information services

During the in-depth interview, conversations were recorded with the consent of the interviewees, and detailed transcripts of the interview were inductively analyzed using grounded theory approach (Glaser & Strauss, 1967). The contents, comprising the four categories in Table 1, were organized by an iterative constant comparison by focusing on keywords. The results are presented in the following section.

4.1.1 Information needs and information-seeking behavior

University hospital physicians encounter many patients with rare or complex diseases, and these cases are difficult to diagnose based on existing clinical practices. Thus, the physicians searched for current studies using PubMed or Google Scholar and studied those papers in depth. These physicians' need for information on general diseases was easily addressed

with textbooks or EBM Database. Conversely, the needs of physicians in specialty hospitals or primary care clinics focused only on clinical practice. These physicians encountered patients with general diseases in most cases, and information on these diseases was readily available. These physicians' information need was to remind them of what they had previously known. Therefore, those in specialty hospitals or primary care clinics depended on their peers by seeking the required information from conversations with other physicians. These physicians mentioned that the reason they had difficulty accessing various information sources was that they spent long hours treating patients compared with physicians in university hospitals. A pediatrician noted that he was treating 130 to 150 patients per day and thus did not have sufficient time to research information.

The differences in information needs and preferred sources were observed even in physicians in the same department by type of hospital. Although Leckie's study investigating information-seeking behaviors of physicians in hospitals, clinics and community medical centers noted that the patterns were different by department rather than by type of hospital (Leckie et al., 1996), this study observed that the differences were greater by type of hospital than that by department. In comparing the answers of pediatricians in university hospitals and primary care clinics, a pediatrician in a primary care clinic considered exchanges among peers most important and largely depended on those conversations whereas pediatricians in university hospitals did not rely on an opinion exchange among colleagues because their specialties were segmented and required academic research. The patient groups in university hospitals were different, which was also mentioned by a rehabilitation doctor. This rehabilitation doctor additionally insisted that his own patients' records were the most important information sources and could be used as research topics, and this physician spent a great deal of time collecting and managing data. A study by Osheroff et al. also indicated that physicians could gather more than half of the required information for medical treatment from medical records and obtain other information from their existing knowledge, patients and published sources (Haines, Light, O'Malley, & Delwiche, 2010).

In addition, physicians' information requirements and the behavior displayed to meet those needs were observed to be comparatively limited in this study. Physicians knew of or searched only a few sources. The physicians were familiar with the existence of new sources but did not actively consider their use. The majority continued to use sources that they had been using because they were undergraduates or residents. The physicians also did not experience a need to access other sources; these doctors were satisfied and confident in their search abilities. The satisfaction was not related to the number of sources used, search results or type of hospital. These findings are summarized in <Table 4>.

Characteristics of information-seeking behavior based on the results of the interviews are presented in the following section.

〈Table 4〉 Physicians' information needs, information-seeking behaviors, and satisfaction

Category	Sub-category	University Hospital	Specialty/Clinics
Types of information needs	Treatment	20%-30% of information needs	100% of information needs
	Research	70%-80% of information needs	-
Characteristics of information needs	Simple Diseases	1. Occur occasionally but are generally related to other clinical departments 2. Occur when writing prescriptions or referrals	Mostly forgot about certain medication information
	Rare Diseases	Search information regarding rare diseases and special cases generally becomes a research task.	This type of information is rarely sought because patients with rare diseases are generally sent to university hospitals.
Methods of information use	Colleague	There is little exchange of information with colleagues.	Highly dependent on colleagues
	Textbook	To access simple information	Used during the physicians' early career but not anymore
	Journal Articles	Information is searched from published journal papers because rare diseases are not mentioned in textbooks.	
Satisfaction	Searchingand Results	Degree of satisfaction is generally 90%. Confident in his/her own ability to search for information accurately and efficiently. (If physicians cannot find the information, they believe there is no published research on the topic.)	Satisfaction is quite high (95% or more).

First, physicians searched for information using familiar methods depending on their own experiences. Physicians preferred familiar methods although the methods were not efficient. The physicians tended to be reluctant to use other methods although these doctors were familiar with the existence and advantages of the new methods. However, once the physicians used a new search method, they did not return to the old methods. Thus, library instruction service on the use of sources must be provided. Second, the results showed the lack of available information regarding the sources. To address that problem, libraries and reference desks should educate physicians on various sources and help the physicians utilize those sources. Third, poor accessibility of medical sources functioned as an obstacle to searching for information. In particular, physicians, except those in university hospitals, did not use for-fee sources and did use a limited range of sources. Thus, the physicians depended on information exchanges among peers and textbooks from their student days. Because the subjects rarely address their information needs on the Internet, the introduction and the promotion of free online sources are necessary to assist

them in doing so. Information can be provided at academic conferences in which primary care physicians participate. In addition, Google Scholar, showing free information first, can also be useful. Finally, considering the previous three findings, the subjects showed uneven use patterns but satisfied their search process and results.

Thus, the arrangement of information sources was first designed for users to directly access what they wanted in the newly developed search system, and the system needed to be designed to encourage the use of appropriate sources by connecting various sources.

4.1.2 Types of research

Respondents to questions regarding research were all physicians in university hospitals, and most physicians said that they faced many difficulties when seeking information for research. Physicians' satisfaction and requirements differed by departments. Physicians in departments in which many studies had previously been conducted encountered obstacles when choosing subjects. In terms of types of research, experimental studies were conducted more often than clinical studies because of strengthened IRB regulations to protect subjects' rights and safety. Collaborative studies were conducted more often than studies by single authors. Although many joint studies have been conducted, some physicians conducted single-author studies according to their personal characteristics. Although the respondents positively evaluated the development of the electronic information environment, the modernization of experimental equipment, and the social circumstances of promoting research, physicians cited as difficulties the lack of time and human resources, strengthened IRB regulations, the strong need for the systematic management of patient data and insufficient financial support.

4.1.3 Preferred medical sources

These physicians in university hospitals reported that the reliability of information was more important than search functions in choosing a source, and the physicians wanted to be able to use just one site to search for information rather than having to repeat the search process on several sites. Thus, physicians were observed to use one source continuously rather than various sources. The physicians preferred an interface with a single search bar, and they experienced difficulty filtering search results because the doctors sought the information too simply. Although the physicians were satisfied with search results from other countries obtained through PubMed or Google, their satisfaction with Korean results was relatively low. Most of all, the physicians lacked sufficient information to choose a Korean source. The physicians also noted that they had to repeat the same search process on several sites because the sites provided different ranges of Korean journal articles. The physicians required a site that worked as a map to access appropriate information because they did not have sufficient information on types of sources or free sources.

4.1.4 Use of EBM sources and suggestions

The recognition of EBM sources was quite low among most respondents, and many EBM sources required payment. Moreover, the participants in this study recognized the need to use clinical guidelines but did not know how to obtain those guidelines. The majority of the physicians used booklets distributed during conferences sponsored by their societies and voiced a desire for the guidelines to be collected and disseminated by a search system at the national level. The physicians also emphasized the need for dates of publication, updating guidelines, copyright information, and particularly information regarding an editor. Reliability can be determined according to the suppliers of the contents of sources for physicians. Because the guidelines are currently being actively produced in South Korea, the physicians expected that easy access to the guidelines could save time and contribute to the upgrading of the quality of medical treatment. These findings are presented in <Table 5>.

Knowledge and utilization levels of EBM were quite low; however, many physicians insisted on the necessity of free sources that could access the essential functions of medical guidelines. In developing a search system, this study considered these suggestions.

〈Table 5〉 Use and suggestions of EBM resources

Category	Answers	No. of respondents
Use of EBM resources	Lack of awareness of EBM resources.	20 (83.3%)
	Access is difficult because it depends on expensive databases.	8 (33.3%)
	Current clinical guidelines were never used during treatment.	5 (20.8%)
	Reference clinical guidelines developed by U.S. and U.K.	5 (20.8%)
	See the clinical information by international societies.	4 (16.7%)
	Current clinical guidelines are simply summaries of textbooks.	3 (12.5%)
	Most clinical guidelines are translated from the U.S. guidelines.	3 (12.5%)
Suggestions regarding clinical guidelines	Korean clinical guidelines urgently require development.	10 (41.7%)
	Need to be regularly updated.	10 (41.7%)
	Need to index full-texts as well as title and keywords.	6 (25%)
	It is necessary that evidence be collected and organized.	5 (20.8%)
	Clinical guidelines are distributed in book form at conferences.	5 (20.8%)
	In clinical guidelines, consensus is important.	4 (16.7%)
	A comprehensive national service is required.	3 (12.5%)
	Residency training in clinical guidelines will be effective.	4 (16.7%)
	Clinical guidelines should be provided as an integrated search service.	3 (12.5%)
	Regulations for the mandatory use of clinical guidelines and incentives to use the guidelines are required. → Otherwise, many physicians do not use them.	1 (4.2%)

4.2 Menu of the search system

A search system was developed reflecting physicians' information needs as shown in the results of the interviews and their suggestions that being able to search for clinical guidelines is necessary. The Clinical Guidelines menu collecting all clinical guidelines on the Web and searching for their full texts with Lucene was designated as the first menu item. For doctors in university hospitals with stronger information needs for research, PubMed and Google Scholar were linked to search for recent medical papers. For physicians' need for information on free medical sources, the My Source menu was added to allow users access to useful free medical sources and to compile their own Favorites list by selecting preferred sources.

4.3 The suggestions regarding MediSearching

To obtain users' opinions and suggestions regarding the search system's interface and menu composition, a second interview was conducted with seven physicians who contributed numerous opinions regarding information sources. According to the results, participants' satisfaction with a single search bar and the Clinical Guidelines menu reached the highest level. None of the interviewees were familiar with the existing search sites of Korean clinical guidelines. These physicians used general search engines such as Google to obtain general information regarding a disease, including clinical guidelines. Therefore, the interviewees were satisfied that they could search clinical guidelines rapidly and accurately.

The participants responded that the results page helped them determine the appropriateness of results because the page displayed the names of societies and the copyright years in one place. In addition, physicians in university hospitals focusing on research positively evaluated the ease of access to PubMed and Google on one site. An otolaryngologist who had conducted clinical studies to develop medical guidelines positively evaluated the feasibility of MediSearching. Similar research-producing medical guidelines will be developed with the financial support of the Korean government, and MediSearching could function as a useful access point to distribute the enhanced guidelines. Many interviewees mentioned the usefulness of the My Source menu, which can save frequently used sources as Bookmarks. The physicians displayed the same attitude regarding the feasibility of a menu such as the menu shown in Ketchell's study. After identifying frequentlyused sources of 37 physicians from three clinics, Ketchell provided a menu linking the sources and investigated the physicians' satisfaction. According to the results, the customized service helped the physicians search for informtion for medical consultation and treatment rapidly and easily (Han & Lee, 2006).

Finally, the interviewees articulated their intention to actively use the website developed in this study if it is put to practical use. Their answers are presented in <Table 6>.

〈Table 6〉 Suggestions for MediSearching Interface

Category	Answers	No. of respondents
Construction of main page	A single simple search box	7 (29.2%)
	Convenience of linking frequently used sites in a single place	5 (20.8%)
	Setting PubMed as the default menu	2 (8.3%)
	Filtering options in Clinical Guidelines menu for search by diseases and symptoms	1 (4.2%)
	Improving the usefulness and effectiveness of clinical guidelines by providing various access points	1 (4.2%)
Characteristics of search menu	More useful menu for Clinical Guidelines	5 (20.8%)
	Convenience of searching the same key word in PubMed and Google Scholar simultaneously	3 (12.5%)
	Need for the advanced search menu of PubMed	1 (4.2%)
	Need for tips for search on the screen	1 (4.2%)
Display of search results	A display showing integrated search results and the results by menu separately	4 (16.7%)
	Displayed information such as the names of societies and the publishing dates, which are useful in rapidly determining whether search results are appropriate	4 (16.7%)
My Source	Usefulness of the Bookmark menu for frequently-used sites	4 (16.7%)
	The configuration of settings by personal accounts	2 (8.3%)
	Need for more options for users to choose and compile sources freely	1 (4.2%)

4.4 Feedback from test search using Clinical Guidelines menu in MediSearching

Three physicians tested the accuracy of the search using the Clinical Guidelines menu. Their results were compared with the results of MediSearching to check its appropriateness and satisfaction level. All participants indicated the highest satisfaction with the results of MediSearching. Compared with the results from KGC, the rate of appropriate results was observed to be high for all thirty words. Compared with KoMgI, the rate was relatively high; the rate was observed to be higher, the same, and lower for 53%, 37%, and 10% of the words, respectively. The comparison with PubMed showed that the rate for MediSearching was higher, recording 87.81% compared with PubMed's 48.59%. For PubMed, the rate for non-clinical guidelines, papers or non-English sources was high. The feedback results showed PubMed's possibility as an information source to search for clinical guidelines.

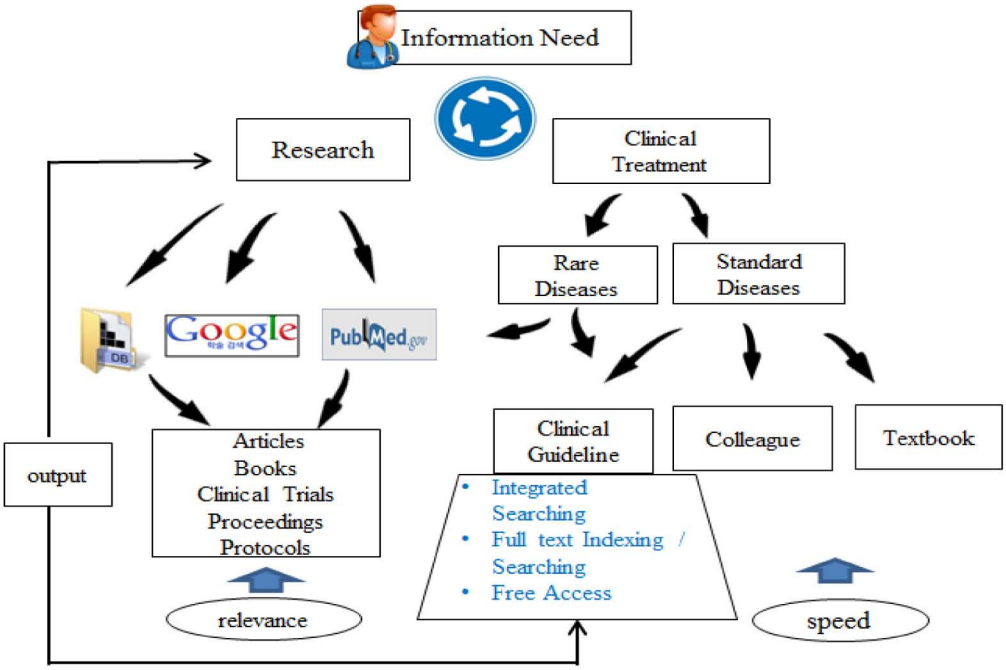
5. Discussion

According to the results, physicians' information needs differed significantly according to the type of hospital in which they worked. Most existing studies on physicians' information-seeking behavior include mainly primary care physicians or family care physicians as their subjects, and their information

needs were related to clinical practice (Davies & Harrison, 2007). However, the subjects of this study were various groups of doctors, including physicians at university hospitals. These physicians sought current papers from academic Database, and this information on rare or ill-defined diseases is not simple. In addition, the lack of sources for Koreans' particular situation was highlighted as the greatest challenge. The participants faced difficulties in handling their information needs, particularly needs related to clinical practice. Most physicians fulfilled their needs by conversations with other physicians; however, this method includes many limitations, such as the lack of time or medical knowledge. To complement this method, many participants suggested the need for national-level systematic support to provide clinical information such as guidelines recognized by academic societies.

Based on the interview results, a Clinical Guidelines menu was formed by collecting the guidelines from various websites using a web crawler, indexing even full texts with Lucene (an open source), and showing search results with the names of societies and copyright dates available at a glance. The process is presented in <Figure 4>.

Physicians' information needs were largely divided into research needs and clinical practice needs, and their information-seeking behaviors differed by need. To address the need for research, the participants searched recent journal articles using PubMed.



〈Figure 4〉 Physicians' information needs and information-seeking behaviors

For clinical needs, their behavior differed based on whether the disease or diagnosis the physicians were searching for was rare or unknown. If the disease or diagnosis was rare, the behavior was identical to the behavior for the information needs for research. If the disease or diagnosis was basic, the physicians' needs were handled by conversations with other physicians, textbooks, and clinical guidelines. That solution was similar to Davies's findings on the information-seeking behavior of doctors (Davies & Harrison, 2007), which stated that information needs for clinical practice were simple and the subjects used text sources in most cases.

Among the various aspects of Wilson's model, such as psychological, demographic, role-related, interpersonal and environmental variables and source characteristics, information-seeking behaviors of the physicians were observed to be affected by three variables: social roles, environmental variables, and the characteristics of sources (Osheroff et al., 1991). Psychological tendencies or demographic backgrounds did not influence their behaviors. In particular, their information needs differed largely by type of hospital as an environmental variable, and characteristics of sources determined by accessibility and reliability were critical variables. In addition, the physicians' use of information sources differed according to the manner in which their social roles related to the range of medical practices and research. Although physicians in specialty hospitals or primary care clinics utilized clinical guidelines as sources to address their information needs, physicians in university hospitals focused on developing the guidelines through clinical research rather than using the guidelines.

MediSearching was developed in this study as a search system to support physicians' information-seeking behavior; MediSearching can help physicians fulfill their needs themselves, save time, and access medical sources more easily. In addition, if Korean medical societies publishing clinical guidelines and centers supporting clinical studies cooperate, MediSearching can collect more medical information and make more content available. Cooperation with medical libraries and research institutions can also improve service to support physicians doing research and eventually increase physicians' satisfaction with the medical library service. Korean physicians rarely recognized the EBM sources and rarely utilized them. In particular, physicians in specialty hospitals or primary care clinics who did not use for-fee information sources considered discussion with peers important to fulfill their information needs and largely depended on these conversations. However, these physicians can address their needs independently using MediSearching, which can search clinical guidelines and PubMed.

Moreover, MediSearching provides a search model for other specialized fields such as education, business, and law. The system will be even more helpful when information-seeking behaviors and favorite sources are investigated and the findings are reflected in designing a system.

6. Conclusions

This study developed a search system based on physicians' opinions and suggestions observed while investigating their information-seeking behaviors. Its usefulness and possibilities were verified by test searches.

Based on the results of the interviews, MediSearching is considered a system useful for all physicians' groups. The Clinical Guidelines menu obtains information on clinical practice such as diagnosis, therapy and drugs. In particular, the system can search clinical guidelines produced in Korea and can simply add new guidelines for continuously updated information. PubMed and Google Scholar are also linked for physicians in university hospitals treating patients with rare or ill-defined illnesses to search current medical papers or clinical trials. These two sources were preferred by physicians in the first interview.

MediSearching was developed by considering the subjects' need for one-stop service to address all of their information needs on one site. In addition, research and clinical practice needs cannot be clearly separated and can arise simultaneously; this new system was developed to allow selective access.

MediSearching is expected not only to improve the accessibility of Korean clinical guidelines but also to play an important role as a medical information source with reliable contents. By continuously collecting clinical guidelines by MediSearching and being supported by the Korean government for clinical studies, a useful knowledge database service is possible for various medical sectors. This service can also work like a hub to deliver and share medical knowledge in libraries and easily provide primary care doctors with reliable information sources easily and without charge.

Considering the information-seeking patterns of physicians, who prefer simple and practical search methods, medical libraries should provide educational programs on bibliography management tools and information search tools so that the physicians have the knowledge to access a variety of useful information sources. In further studies, the clinical guidelines collected by MediSearching can be analyzed by symptoms, diseases, age, and other useful access points that could be meaningful search options for a specific and efficient search.

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