Medical scientists' information practices in the research work context

Roos, Annikki

2015-03


http://hdl.handle.net/10138/173140
https://doi.org/10.1111/hir.12095

Downloaded from Helda, University of Helsinki institutional repository.

This is an electronic reprint of the original article.

This reprint may differ from the original in pagination and typographic detail.

Please cite the original version.
Medical Scientists’ Information Practices in the Research Work Context

Annikki Roos
Hanken School of Economics, Helsinki, Finland and Terkko – Meilahti Campus Library, Helsinki University Library, University of Helsinki

Acknowledgements:
Dr. Turid Hedlund and Dr. BoChrister Björk from Hanken School of Economics, Information specialists Eeva-Liisa Aatola, Tiina Heino, Mari Elisa Kuusniemi and Katri Larmo from Terkko – Meilahti Campus Library at University of Helsinki.

This is the pre-peer reviewed version of the following article: Roos, A., Medical scientists’ information practices in the research work context. Health Information & Libraries 2015, 32 (1), which has been published in final form at Health Information and Libraries Journal

OBJECTIVE: The aim of the study was to investigate the information practices of medical scientists in the research work context.

METHODS: This is a qualitative study based on semi-structured interviews. The interviews were transcribed and analyzed in a web tool for qualitative analysis. Activity theory was used as the theoretical framework.

RESULTS: The generating motives for the information related activity come from the core activity, research work. The motives result in actions such as searching and using information. Usability, accessibility and easiness are the most important conditions that determine information related operations. Medical scientists search and use information most of all in the beginning and at the end of the research work.

CONCLUSIONS: Information practices appear as an instrument producing activity to the central activity. Information services should be embedded in this core activity and in practice libraries should follow researchers’ workflow and embed their tools and services in it.
Key message

• Medical scientists’ information practices should be studied in the research work context.

• Medical libraries should embed their services and tools in the researchers’ core activity, the research work.

• Information services and tools for medical scientists should be accessible and easy to use.
Introduction

The aim of this study was to investigate and understand the information practices of researchers in the biomedical domain. Our purpose was to put medical scientists information related practices into a broader, research work context and analyze the practices through the activity theoretical perspective. We also intend to contribute to the domain-analytic discussion within information science research, as introduced by Hjørland and Albrechtsen. The domain-analytic approach argues that domain or discipline is important in understanding the information practices of researchers. The managerial implications of this study will be to find and present new approaches to develop information services for medical scientists.

The main focus is on the information practices of the "medical scientists or physician-scientists" which means biomedical researchers in clinical settings. Biomedicine means "medicine based on the application of the principles of the natural sciences and especially biology and biochemistry." Medical scientists engage frequently, but not always in clinical research, which means that the research involves directly a human being or a group of people or that it uses materials from humans, like samples of tissues.

The main research questions of the study are:

1) What are the most information intensive stages in medical scientists’ research work?
2) What are medical scientists’ most common information practices and tools?
3) Do researchers experience information related problems (and what kind of problems) during the research work?

Background

"Information practices" is a concept often discussed but lacking a fixed meaning in information studies. If compared with the term "information behavior", the focal point in "information practices" is in the social and cultural dimensions of the information related activities and the nature of the relationship with the environment. With "information practices" we mean practices of seeking, managing, giving, and using information in context.
Earlier studies confirm that journals are the most important source of published information in the biomedical domain, and PubMed the most important reference tool for information seeking. \(^7\sim11\) Google is also an important tool for searching information \(^12\). PubMed is used mainly because colleagues or supervisors have recommended it. \(^8\) Haines et al. \(^16\) described more varied information sources, which were accessed depending on the nature of the information need.

Researchers prefer convenience, accuracy and ease of access to their information acquisition. \(^8,9,13\sim14\). They use a “trial and error” tactic, simple, single box search interfaces without any search strategy. Subject searches by index terms are rare and search is done generally by typing a few keywords and browsing through received titles. \(^15\) Researchers do searches by themselves, without the help of manuals or the library. \(^8,9\) Colleagues are important in providing the most recent information about articles and other resources. \(^12,16\)

Most scholars are satisfied with their information skills. Because researchers are self-taught or have learned how to search from their colleagues, their skills are similar to the way lay people use general search engines \(^10,15,17\). They are not interested in instruction organized by the library \(^8,16\) and do not consider librarians as a valid information source, able to solve their information related problems. \(^18\)

Even though researchers mentioned the lack of time, lack of skills or knowledge about tools and sources as a barrier to information seeking, it seems that they do not experience the lack of skills as a hinder in the way it is observed in libraries. \(^8\).

Some of the main findings of the previous studies are presented in Table 1.
<table>
<thead>
<tr>
<th>Information practice/source</th>
<th>Findings</th>
<th>Research method (sample size)</th>
</tr>
</thead>
</table>
| Source of published information | Most important source: journals | - survey (902)<sup>9</sup>  
- participant observation + interviews (24)<sup>8</sup>  
- telephone survey (500)<sup>12</sup>  
- survey (2063)<sup>13</sup> |
| Reference tool | Most important tool: PubMed | - interviews + focus groups (40)<sup>10</sup>  
- survey + interviews (116)<sup>11</sup> |
| First source of information | PubMed or Google | - interviews (9)<sup>16</sup>  
- participant observation and interviews (24)<sup>8</sup>  
- survey (116) + interviews<sup>11</sup> |
| Researchers preference in information acquisition | Convenience, accuracy, ease of access | - participant observation and interviews (24)<sup>8</sup>  
- survey (902)<sup>9</sup>  
- interviews + focus groups (40)<sup>10</sup> |
| Search tactics | Trial and error  
Very basic strategies | - participant observation + interviews (24)<sup>8</sup>  
- think aloud + qualitative observations (32)<sup>15</sup>  
- survey (902)<sup>9</sup> |
| Information related problems or barriers | No information related problems, lack of time  
Researchers are satisfied with their information finding skills | - telephone survey (500)<sup>12</sup>  
- interviews + focus groups (40)<sup>10</sup> |

Table 1. Main findings from previous studies

**Activity theory and research work as an activity**

Previous research on information practices of biomedical researchers has been mostly pragmatic and fragmentary without a theoretical background or analyses of the context of the practices. The author found a lack of studies, where biomedical information practices would have been set in a broader context of the research work. To be able to construct a holistic picture, a theoretical framework was chosen, which assists in analyzing and understanding information practices more deeply. Activity
theory is one of the theoretical frames that help to analyze human activities or practices. According to cultural-historical activity theory (short: activity theory), all activity is purposeful interaction between the subject and the material world. An activity system, which according to Engeström should be the prime unit of analyzes of all kinds of activities, is composed of interacting elements. The basic elements of the activity system are presented in Figure 1.20

![Figure 1. Engeström’s complex model of the activity system](image)

The object of activity, “why”, is behind the whole activity. The object will be transformed to outcomes through a hierarchical process.21 The relationships between subject, object and community are mutual. Mediating artifacts are always included in the relationships; tools, rules and the division of labor are mediating artifacts. Contradictions between the elements and between different activity systems are central to the change and development of activities and learning.19,20,22

The activity system can be seen as a part of the embedded web of activity systems including central activity and object activity. Object activity includes activities where the objects and outcomes of the central activity system are embedded. Central activity is surrounded by subject-, instrument- or rules-producing activities.23,24 When we want to understand information practices (human activities) of medical scientists (subject), we have to take into account that these practices are situated, meaning that the physical and social context determine them.25 Figure 2 outlines the web of activities in medical scientists’ research work (central activity), clarifies the variety of activities and the complexity of the context and helps in situating information practices to it.
Scientific research work has some special features compared with other work activities. The dominant value of modern sciences is to produce new knowledge. Because of this, the outcomes of the research work tasks are uncertain and non-routine compared with the tasks and outcomes of many other work organizations. Scientific fields are different in relation to the degree of control, i.e. how research should be done and competence evaluated (mutual dependence), and in the degree of uncertainty of tasks. Task uncertainty in biomedical discipline is lower and the degree of mutual dependence higher than for example in humanities or social sciences. This is reflected in the creation of knowledge and communication. In biomedicine, research results are produced in quite a standardized way and reported in a formalized manner in journal articles.

In information science, activity theory has been pointed useful in providing a holistic approach to the study of information practices or information behavior in context. A few researchers have brought up the benefits of the terminology of the activity theoretical frame and the hierarchical nature of activities in studying information practices in context.

We have chosen to examine our data against the activity theoretical framework in order to obtain a more holistic understanding of the information practices of medical scientists.

Figure 2. Web of activity systems in medical scientists’ research work context. Adapted from Engeström.
Methods and settings

Because the aim of the study was to get detailed and deep understanding of information practices, a qualitative approach was motivated.\textsuperscript{32,33} We think that the qualitative approach gives possibilities to collect and analyze personal experiences and views in a deeper way compared to surveys, which have previously been the most common method to study information practices among researchers\textsuperscript{16,34}. We have found semi-structured interviews as the most appropriate way to collect data. Semi-structured interviews are open and give possibilities to develop new, advanced questions during the interview. The guide that we used in the interviews is based on the results of a previous study of the author and it is attached as a supplement to this article.

The strategy to choose the interviewees was purposeful sampling or theory-based sampling using the activity theoretical framework.\textsuperscript{35} We used the snowball technique (see e.g.\textsuperscript{36}) by asking, mainly from seniors, to provide new contacts for the next interviews. The strategy was initially to cover as broadly as possible the topic of medicine and second, to recruit researchers from different stages of their research career and different positions in the research community.

We focused on researchers and research groups from the Helsinki University Central Hospital and the University of Helsinki. We included researchers from various medical fields and at different stages in their research career. Twelve researchers were interviewed. We were also able to recruit one researcher to demonstrate her search procedures. Six of the researchers were clinicians, one pediatrist and three pharmacogenetic researchers who were also using clinical material in their work. Two researchers came from the public health domain and based their research on register data. More detailed information about the researchers (n=12) is included in Table 2.

<table>
<thead>
<tr>
<th>Medical field</th>
<th>PhD Students</th>
<th>Seniors</th>
<th>From which Clinicians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstetrics &amp; gynecology</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Otorhinolaryngology</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pediatrics</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pharmacogenetics</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Public health</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>
Table 2. Information about the interviewed researchers

The interviewers, totally five people, came from the medical library, four of them being information specialists and one the director of the library.

The interviews were recorded and transcribed to relevant parts and thematic analysis was used to segment and code the data. An analysis tool called Dedoose (http://www.dedoose.com) was used to structure and code the material. All the transcribed interviews were loaded into the tool, were read thoroughly and relevant parts of the texts were highlighted and selected for further analyses. Texts were excerpted and grouped basically according to the main elements of the activity system.
Results

Division of labor in the research community

Research is basically carried out in groups. The actors and their roles in these groups may vary depending on the group and the research object. A group consists of the principal senior researcher, other senior researchers and PhD students who in most of the cases are physicians specializing in a medical field. Some of the groups have collaborative partners in different universities in Finland and abroad.

PhD students are the main authors of the articles. Seniors, especially principal investigators supervise the work. Other members of the research group contribute to the writing mainly by commenting on the contents. The groups don’t use any group work tool to assist in the sharing of documents during the writing process. Researchers work in laboratories, departments and clinics, where they also have access to all the material they need, including published information. They visit the library only in an extreme need. Seniors will hardly ever come to the library and if they have a need, they will send a junior.

The web of activities in research work

The web of activities in research work (see Figure 2 above) is dynamic and all the elements of the activity systems interact with each other. Every activity system consists of various, hierarchical activities. When the activity system is studied from the point of view of a research group or a single researcher the web of activity systems is slightly different. The importance of the neighboring activity systems or the object of the activity may vary. A specializing clinician, for example a PhD student, might in practice focus on the exam whereas the objective of seniors or principal investigators was clearly in developing new knowledge to prevent and cure diseases. The aspects of scientific reputation and securing of funding also seemed be present in their objectives. One of the PhD students indicated that her object had changed during the work. Clinical work activity had different impact on the research work and vice versa depending on the organizational status and experience of the researcher. Seniors and principal investigators could combine their clinical and research work while clinicians who were PhD students said that these two were completely separate. The information work activity system includes ICT and information services.
The chain of actions in the research work activity

The idea for a new research project might come from an astonishing laboratory result, clinical cases, the experience of the researcher, discussions with colleagues or published literature. The idea matures gradually with the help of colleagues and the literature, which is searched at this stage usually from PubMed database. When the research plan is completed, it will go through the ethical evaluation process. After permissions, the research will be launched. What follows depends on the research frame. In some cases, the next stage is to recruit the patients. The recruited patients will be examined and laboratory samples collected. In other cases, where the samples already exist, the laboratory and statistical analyses might be conducted instantly and the preliminary results will be in hand and the proper research work will start. Literature will be searched and used during the reflection stage, perhaps a new idea for a totally different project for the future will appear and the writing stage will start. During the process of writing the role of searching and reading the previously published literature is important. Monitoring, maintaining awareness of developments in a field through the monitoring of particular sources, is done continuously during the research process.

The process is described here at a general level and differs between different subjects, e.g. senior and junior researchers. PhD students who are starting their research careers for example receive their research subject, at least at the beginning of the project mainly from their supervisor or from other seniors. However, the information intensive stages are quite similar.

The chain of actions, how various actions flow in the medical research work is presented in Table 3. The stages 4-6 are in parenthesis because they occur invariably.
<table>
<thead>
<tr>
<th>Action</th>
<th>Subject</th>
<th>Tools</th>
<th>Object</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Research idea construction</td>
<td>(Senior) researcher, PI Prev. results, experience, dialogues, clinical cases</td>
<td>A new idea</td>
<td>Research questions</td>
<td></td>
</tr>
<tr>
<td>2. Making research plan</td>
<td>(Senior) researcher, group leader or PI Literature, dialogs</td>
<td>Make research plan</td>
<td>Research plan</td>
<td></td>
</tr>
<tr>
<td>3. Ethical evaluation</td>
<td>Ethical committee Ethical principles</td>
<td>Get approval</td>
<td>Permission</td>
<td></td>
</tr>
<tr>
<td>4. Recruit patients</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>5. Examine patients</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>6. Take samples</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>7. Laboratory analyses</td>
<td>Laboratory personnel, chemists Laboratory tools and methods</td>
<td>Analyse samples</td>
<td>Laboratory results</td>
<td></td>
</tr>
<tr>
<td>8. Statistical analyses</td>
<td>Researcher Statistical tools and samples</td>
<td>Analyse results</td>
<td>Statistical results</td>
<td></td>
</tr>
<tr>
<td>9. Reflecting</td>
<td>Researcher Experience, knowledge, research results</td>
<td>Find reportable final research results</td>
<td>Final research results</td>
<td></td>
</tr>
<tr>
<td>10. Writing results</td>
<td>Researcher with the other members of the research group Previous literature, writing tools</td>
<td>Report the results</td>
<td>Scientific article</td>
<td></td>
</tr>
<tr>
<td>11. Publishing results</td>
<td>Researcher, research group Dialogs, correspondence</td>
<td>Publish the results</td>
<td>Published article</td>
<td></td>
</tr>
<tr>
<td>12. Observing the impact of the article</td>
<td>Senior researcher, PI Bibliometric or/and altmetric tools</td>
<td>Evaluate the impact of the work</td>
<td>Evaluation of the impact</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. The chain of actions in the medical research work.

Researchers pointed out that they were searching and using published information mostly in the beginning, at the idea creation and research plan writing stages, and towards the end, in the results reporting phase. In clinical research, where patients are often directly involved, the research plan writing stage needs a special attention. The research plan may be strictly binding and it has to be made as skillfully as possible because fatal changes for example in the research frame would lead to the need for a new ethical evaluation and could cause the end of the whole experiment. Because of this, the research plan stage from the point of view of information seeking appears to be even
more important in clinical research than in for example more laboratory based molecular medicine, where patients are seldom directly recruited.

**Information related actions**

In this section, we analyze more precisely the structure and hierarchy of researchers’ information related actions during the research process. The central activity system, research work, generates the motive to the information related actions. We present in Table 4 the goals and related actions that we were able to identify from our material. After that follows a more accurate exploration of the most important information related actions.

<table>
<thead>
<tr>
<th>The chain of action</th>
<th>Goal</th>
<th>Information related action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research idea</strong></td>
<td>- Find out if the research idea is relevant</td>
<td>- Dialogs with colleagues</td>
</tr>
<tr>
<td></td>
<td>- Be aware of new knowledge about the subject</td>
<td>- Follow (monitor) development of knowledge in the subject</td>
</tr>
<tr>
<td></td>
<td>- Understand the phenomenon/subject</td>
<td>- Find all existing information about the phenomenon</td>
</tr>
<tr>
<td></td>
<td>- Refine the research questions</td>
<td>- Search information about methods</td>
</tr>
<tr>
<td></td>
<td>- Make a consistent research plan</td>
<td>- Read about former results and think</td>
</tr>
<tr>
<td></td>
<td>- Be aware of new knowledge about the subject</td>
<td>- Discuss with colleagues/supervisor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Follow (monitor) development of knowledge in the subject</td>
</tr>
<tr>
<td><strong>Research plan</strong></td>
<td>- Find and construct answers to the research questions</td>
<td>- Find support from previous literature to the reflecting process</td>
</tr>
<tr>
<td></td>
<td>- Be aware of new knowledge about the subject</td>
<td>- Follow (monitor) development of knowledge in the subject</td>
</tr>
<tr>
<td><strong>Reflecting</strong></td>
<td>- Ensure that all existing information is taken into consideration</td>
<td>- Find all existing information about the subject</td>
</tr>
<tr>
<td></td>
<td>- Be aware of new knowledge about the subject</td>
<td>- Follow (monitor) development of knowledge in the subject</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Follow citations of the article</td>
</tr>
<tr>
<td><strong>Observe the impact of the</strong></td>
<td>- Find out the impact of the published work</td>
<td>- Follow (monitor) development of knowledge in the subject</td>
</tr>
<tr>
<td>published article**</td>
<td>- Be aware of new knowledge about the subject</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. The chain of information related actions in the medical research work
Search information

Searching the references of published articles appears as the most common and perhaps the most important information related action. The tool that all researchers used for searching literature was PubMed. Searching by subject is done almost always by simply writing few words into the search field. “In the beginning I’ll just write a few, relevant words in the particular [search] field - and I’ll see a horrible amount [of references].” If the search turns out to be too broad, gives too many references, or too narrow, gives only a few or no references at all, a new search is be done by modifying it a little. “I will make more specified and detailed searchers later in PubMed with authors’ names and publishing years...” If the subject is unfamiliar or there are no results from the PubMed search, Google is used to help to find more information about the subject and to help in constructing the following search, which is nearly always done in PubMed. “I’ll use Google if I’m not able to find anything sensible from PubMed”. One PhD student named reviews as a helpful tool in those cases where the search term had given too many references. In cases like that, if possible, she chose a review and continued with the references included in it.

One senior researcher used search strings and Boolean operators in his searches. He combined the searches in the PubMed Advanced Search Builder. This senior told that he is using different search strategies depending on the familiarity of the subject. In cases where the topic is unfamiliar or he is making a review article or similar comprehensive work, he will make a systematic search. After the search, he will copy and print all the abstracts and go through all of them thoroughly before choosing the most important articles. When he is working with a more familiar subject, he will make a more focused searches, which do not need to be very systematic, go directly from the references to the articles and straight extract the needed information.

The hierarchy of the activity of finding all existing information about a phenomenon is analyzed roughly in Figure 3.
Figure 3. The hierarchy of actions of searching information about a phenomenon.

The conditions, like the familiarity of the subject, the knowledge of the tool, access and time limits determine how the operations of information searching are actually performed. The conditions seem to vary for example according to how experienced or busy the researcher is.

Monitor and chain

One information related action, monitoring appears continuously during the research process. All researchers wanted to be aware of new knowledge about the studied phenomenon and they emphasized the importance of continually following the most recent publications. Monitoring was not, however, done very systematically. Three PhD students had a constant subject search with email alerts on PubMed. One senior made searches manually from PubMed. Most of the PhD students and some seniors searched occasionally, "checked" information from PubMed. Two seniors followed mainly citations to their own articles from the Web of Science, one PhD student used Scopus for this purpose. One senior used his limited time just in browsing general, printed, scientific journals and used juniors as a source for more specified information. All researchers followed the contents of some important journals mainly by ordering the table of contents from publisher's site or directly from the journal. One researcher could name the RSS feed -tool of the library but she, like all the others, was not using it.

The Web of Science was used in order to follow citations (called chaining) to the researchers' own works. The following of their own citations served also at least to some of the seniors as a way to follow developments in their specialty. Other mentioned information sources were the portal of the Finnish Medical Society (3/12), the web
services of the library (3/12) and web pages of some health or drug authorities. The portal of the Finnish National Electronic Library (2/12) was mentioned only in occasions where the researcher was not able to access the article directly from PubMed. One senior named that he was using a library service called “Scholar Chart”, which helps to follow and compare the impact of different researchers.

Tools and artefacts

The most important single source of information, journal articles seem to act as a source of the “foreground knowledge” to researchers. This is to be expected based on the publishing culture of biomedicine. However, books - mainly textbooks – are used by most (6/8) of the PhD students mainly for looking up basic or general information, “background knowledge” about a subject. Wikipedia was equally popular for the same purpose and could also be used instead of a printed book, if the book was not available. The concepts of “background and foreground knowledge” originate from evidence-based medicine, where the distinction between the concepts is defined by the amount of experience of the physician and by the quality of the needed information. Google had an important role (10/12) both among seniors and PhD students for many purposes; for checking a single fact, verifying a term, get to know a laboratory method etc.

The clinical research work is usually based on samples. Various data resources, like data from patient registers and laboratory data are commonly used. One senior researcher brought up the significance of combining or integrating the data from different sources for research purposes. The researchers, who were doing clinical pharmacological research, used NCBI databases, like Gene or SNP. Different registers are the main sources for public health researchers.

Almost all PhD students highlighted that their supervisor has shared published information with them. The supervisor seems to be an important adviser during the whole process but specifically in the beginning they act as a valuable source of all kinds of information and knowledge. Later, however, the roles may change and the students may act as messengers disseminating some of the most recent information to the busy seniors.

For sharing information, the researchers used to convene with regularity for a so called “journal club” where published information and knowledge in general were distributed within the whole research group. Reference tools like RefWorks or EndNote, which
otherwise were popular among researchers, were not applied in information sharing. One PhD student told that when she was writing a common article with another candidate, they shared a reference library. However, it appeared that the members of the research group discussed the literature and shared single references during the writing process. None of the research groups used a groupware throughout the research work.

Two of the researchers had participated in a course or session that the library organized on the use of a reference management tool. One PhD student who was at the beginning of his studies, had been talking with his supervisor about the usefulness of the library’s courses and he was planning to attend some of them. Another PhD student, almost at the end stage of her studies, admitted that information seeking would probably have been easier if she had been taking part in theses courses. In conclusion, information practices skills were learned by doing or with the help of a supervisor or a colleague.

Contradictions and problems

The main information related problems that the researchers experienced, were related to conditions that determine information seeking operations: lack of time, lack of access to information resources and lack of skills.

Lack of time was the senior researchers’ biggest problem. Several PhD students who were clinicians described the same problem. This could be an expression of a contradiction between objectives of different activity systems, for example research, education, administration or clinical work, in which researchers are involved.

The lack of access to the most recent or older material was mentioned as a problem by almost all of the researchers. They usually started searching from PubMed, found a relevant reference, but many times the full text of the article was missing. From the reference, they had to go to the library’s web page and use the service provided by the library to search the reference again to be identified as a licensed user of the published material. This was found complicated and frustrating. One of the PhD students called this process as “a detour” to the resources: “It’s a problem when you’re not able to get the full text directly from PubMed. Perhaps the clinic has not ordered the journal or I don’t know - because you are able to get it on kind a roundabout way [...] yes the Journal Navigator [library’s catalog] is one of the detours”. It seems that the local information
services provider has not been able to integrate licensed information resources with the main search tool, PubMed.

The interlibrary loan or ordering a copy of an article seemed to be “a twisty detour”, because many of the interviewees told that they would rather try to find another resource (PhD students) "...ordered an article [from the library]? No, no, or perhaps once or twice a few years ago [...] I rather try to find something similar" or ask a copy directly from the author (a senior) than to use the service of the library. The interlibrary loan service of the library was, however, used by several researchers.

A majority of the PhD students found that their skills are inadequate for searching. Basic problems are a) to limit the search in a reasonable way (i.e. too low precision) and b) cover the subject in a way that confirms the inclusion of all the important, relevant material (i.e. recall). Many of them reported that they have difficulties in finding the right search terms. As one of the PhD students concluded, it was easy to get along, but when more sophisticated search of information was needed, problems appeared. The PhD students, who told that they would need gene data, announced that they could not properly neither search nor read the results.

Three of the researchers, however, described that they have experienced information seeking quite easy. The first of them had started her studies a few months before she was interviewed, the second researcher was finishing her thesis and the third one was an experienced senior. According to the senior, junior researches probably experience information seeking more difficult because they don't have enough substance knowledge to be able to filter the relevant from irrelevant. A couple of the PhD students commented alike in their interview that not the searching, but acquiring and processing of the information and knowledge is the biggest problem.

Some of the interviewees were of the opinion that information practices are "learned by doing" during the PhD process. When we asked about the training of the researching physicians on how to use of for example gene databases, we learned that there was no one who actually had concrete training to use these tools but "they are learned like folklore".

PhD students brought up problems or lacking skills in using different programs like drawing or writing tools. They, as well as one senior, reported about problems or
lacking knowledge related to the practices of the remote use of information resources. In problems like these, some PhD students named friends or colleagues as a source of support and help.

**Discussion**

The information environment of the medical scientists in this study was quite consistent, comprising mainly of journal articles and one main searching tool, PubMed compared for example with researchers in data intensive molecular medicine 11.

In the context of research work, information practices appear as an instrument producing activity 23,24, as a tool to the central activity system. The generating motives for information related activity come from the core activity and those result in actions such as searching and using information. Evidently usability, accessibility and easiness are the most important conditions that determine information related operations. The main information related problems that researchers experienced were related to these conditions, namely lack of time, lack of access and lack of skills. It was obvious that different objects of various activity systems, for example administration and research work, were causing contradictions and problems.

Even though medical scientists experienced information related activities as necessary tools in their research work activity, they did not feel much need to learn any particular skills that would help them manage these activities better. The reason for this could be that information related activities belong to the lower level actions on their activity hierarchy. Researchers realized that their skills were at least partly inadequate but however good enough to manage to do the work properly. It is possible that researchers did not appreciate information related skills as such but considered them as a pure technique that is subordinate to their substance knowledge.

In this case it seemed that from the research work perspective, the information work activity system that provided information services (library) was quite separate and isolated from the core work of researchers. Actors who provided these services to researchers were physically located far away from researchers. Even the language differed, interviewers noticed that the terms they used about the services and tools were only partially familiar to the interviewees. The most important advisers in relation
to information artefacts and other tools came from the physically and intellectually nearest research community, colleagues and senior scientists. These “informal” information sources, discussions and dialogs with colleagues were particularly important at the beginning of the research work.

Senior researchers and principal investigators seem to hold a key position in relation to advising information related practices to juniors. In addition to providing courses for PhD students, libraries and information services could take principal investigators as one focus group for their marketing. Informal communication and dialog with researchers in their premises, offices and laboratories should be increased to be able to find a common language for discussions about information related services which would be helpful for them. The formal occasions of the research groups should also be utilized in order to bring forward e.g. good practices in information searching and managing. Virtual tools should be integrated into researchers’ normal workflows and services provided in everyday environment. It appeared unfortunately, that most of the progressive tools developed in the medical library had not found their way to the toolboxes of researchers.

How domain specific, different from other disciplines, are medical scientists’ information practices? In biomedicine research methods and techniques are formal and standardized. The publishing patterns and channels of communication between researchers are also quite standardized. Research is cumulative, new research is founded accurately on the previous results and researches are mutually dependent on each other in a way that differs e.g. from humanities and social sciences. With the help of the activity theoretical framework, the net of the activity systems of medical scientist becomes apparent. It brings up the variety of interconnected activity systems and indicates the challenges that every researcher faces in this domain. Particularly the clinical work activity system, which includes human living patients in clinical trials, differs from mainly laboratory based biomedical domains, like molecular medicine (see 31). It is evident that information work activity, which aims to produce instruments for the research work activity is not able to do that if it is physically or intellectually too far from the core activity.

The earlier research of the information practices in the biomedical domain has been mainly fragmentary and positivistic. Reason for this might be the nature of the research culture of biomedicine. Information studies in biomedicine have perhaps tried to follow
that tradition. This seems to be a mistake. If the aim of information services is to support researchers in their information related practices, it is evident that the domain specific features need to be understood and taken into account. This is possible when information practices are approached from sociological perspective.

**Limits**

A limitation of this study might be the used research method. When using only interviews, we will capture the proportion of reality that people want to tell us. The actual doing will still be in hiding. The fact that the interviewers were from the library might also have an effect on the results. If interviewed by a colleague or an outsider, the outcome might have been slightly different. Participant observation or a similar ethnological method might have given a more realistic picture.

We were able to achieve a broad but still shallow view of the information practices of medical scientists. These researchers comprised from different medical disciplines and it would have been useful and interesting to study each of those more precisely. That would comprise a target for a further study.

**Conclusions**

The main contribution of this study is that with the help of the activity theoretical framework medical scientists' information practices have been put in broader research work context. Information practices appear as an instrument producing activity to the central activity and belong to the lower level of activities in researchers' core work activity.

Medical scientists search and use information most of all in the beginning and at the end of the research work. They search mainly the references of journal articles from PubMed –database. Researchers’ main formal sources of information are journal articles where they also publish their own results. If needed, they find help and support from fellow or senior researchers from the physically and intellectually nearest community. Easiness, accessibility and usability are the most important conditions that determine medical scientists' information related operations.
Finally, this study argues that if the aim of the information services is to support researchers in their information related practices, it is evident that the domain specific features, the characteristics of the biomedical discipline, need to be understood and taken into account. This means that information services should be embedded in the researchers’ core activity. In practice, libraries should follow researchers’ workflow and embed their tools and services in it; link full text resources directly to those tools that researchers use, put library web pages as a part of those web resources researchers are constantly using etc. There is a need for a virtual presence of the library services and tools in researchers’ virtual work environment. Perhaps the biggest challenge is to be able to have a common language with researchers. This might be possible to achieve if work in medical libraries could be more integrated to biomedical research and clinical work context.
REFERENCES


27. Fry, J., & Talja, S. The cultural shaping of scholarly communication: Explaining e-journal use within and across academic fields. *ASIST* 2004, 41 DOI: 10.1002/meet.1450410103


33. Talja, S., & Maula, H. Reasons for the use and non-use of electronic journals and databases - A domain analytic study in four scholarly disciplines. *Journal of Documentation* 2003, 59, 6, 673-691.
Appendix

The topic guide of the interviews

A. Background information
   - education
   - phase of studies/research history
   - if a part-time researcher, the proportion of research work
   - if clinician, about the relation of clinical work and research work
   - basic information about the research group

B. Research subject

C. Partners, collaborators, networks

D. Describe the research process

E. What are the information intensive stages in the research process?

F. Which information sources and tools are used?

G. What information related problems or challenges are encountered?

H. Other
   - working space