



REVIEW ARTICLE

Needle in a haystack? Effective literature searching for research

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INTRODUCTION

This is the third article in the series about research in radiography practice. The first two articles provided a rationale for undertaking research and an introduction to the research process. This article deals with one of the first stages of research, the literature search describing the process and steps to effective searching and undertaking a literature review.

The aim of this article is to provide guidance on undertaking a literature search and the steps involved in writing a literature review. It will provide a rationale for undertaking a literature review, provide details of relevant sources of information for radiographers and when to use them, emphasise the importance of planning a literature search, provide guidance on searching, managing references and on writing a literature review.

RATIONALE FOR REVIEWING THE LITERATURE

A literature search is a search for published information using a range of sources relevant to your research project. The first article in this series highlighted the need for basing practice on re-

search-based evidence and creating new knowledge by undertaking our own research. In both these scenarios a literature review or search is an essential component. In order to base our practice on best available evidence, it is essential that we undertake a search in order to find all the best available evidence for our topic area. An incomplete or ineffective search is likely to miss relevant information, resulting in the possibility that practice is based on incomplete evidence and possibly inappropriate or ineffective decisions being made. In generating new knowledge or research, a literature search is also important. A literature review will provide background and a rationale to your research, highlighting work that has already been undertaken in this field, methods that have been used and areas that remain to be considered. A search will prevent duplication of effort, ideas for how to proceed and confirm or validate the results of your study. Whether in the pursuit of evidence based practice or generating new knowledge, a literature review is an essential component and it is therefore worthwhile taking the time to plan it and understand the techniques involved.

PLANNING THE SEARCH

Searching the literature can be very time consuming and frustrating. Researchers often have problems finding relevant information or finding more

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information than they can manage. In recent years the rapid expansion of the Internet has resulted in increasing amounts of information being [theoretically] available on our desktops within a few clicks of the mouse. Often clinicians are rarely taught sufficient information skills to locate the information they need effectively and therefore become frustrated and/or miss the information they need.

If a literature search is undertaken in a planned and systematic way, however, and the clinician masters some basic techniques, searching becomes easier and the chances of missing information reduce.

One of the keys to more successful literature searching is planning the search. Before visiting a library or sitting down at the computer to search the Internet, it is advisable to think about and consider your search. There are five questions to be considered. These are set out in Fig. 1 and will be considered in turn. Completing the plan will help

focus your thoughts, get you started and if you revisit the plan during your search, it will also ensure that you keep on track whilst doing your literature review.

Why are you doing the search?

Think about the reasons for doing a literature search. The reason for doing the search will affect the type of information you search for and how you search. If you are basing your practice on best available evidence you may be looking for systematic reviews or review articles or summaries of evidence in this topic area. If these do not exist you may wish to look for certain types of high quality research such as randomised controlled trials. If you are doing a major research project that requires a literature review then you will need to locate most of the relevant literature to that project. This could include background policy documents and other research

<i>Question</i>		<i>Response</i>
1. <i>Why are you doing the search?</i>		<div style="border: 1px dashed black; height: 60px; width: 100%;"></div>
2. <i>What are you searching for?</i>		<div style="border: 1px dashed black; height: 60px; width: 100%;"></div>
3. <i>What are your constraints?</i>		<div style="border: 1px dashed black; height: 60px; width: 100%;"></div>
4. <i>What sources?</i>		<div style="border: 1px dashed black; height: 60px; width: 100%;"></div>
5. <i>How comprehensive?</i>		<div style="border: 1px dashed black; height: 60px; width: 100%;"></div>

Figure 1 Planning your search [Adapted from—Brettler A, Grant M]. *Finding the Evidence for Practice: A Workbook for Health Professionals*. Edinburgh: Churchill Livingstone, 2003].

that has been undertaken in this or relevant areas. In contrast you may wish to find a couple of articles to back up a point in a lecture you are giving, in some instances a quick search will suffice.

What are you searching for?

Think carefully about your search question. The more focused the search question, the easier the search. Searching on a particular question is easier than looking for a vague topic area or entering a few terms on a topic you are interested in. You may need to break down your topic area into several questions and search on each individually. Focusing the search question will be considered in greater detail later in the paper.

What are your constraints?

You may have a limited amount of time to undertake the search or restricted access to resources. You may have been given a topic to consider with little flexibility. You need to decide whether it is necessary to overcome the constraints or whether you can work within them and accept the results you obtain. For example, if your research is on a particular topic area and one particular library holds many of the journals relevant to that subject, can you negotiate special access? Alternatively can you make use of interlibrary loan facilities from your own library or limit the search to resources available to you without detriment to your work?

What sources should you use?

Different sources cover different topic areas and some are more suited for specific purposes than others. These issues will be discussed in greater detail below. It is necessary to become familiar with relevant sources, deciding which are appropriate to your research and those to which you can and should obtain access.

How comprehensive should your search be?

The comprehensiveness of the search depends on the search question and reasons for undertaking the search. Clearly if you are embarking on a major research project or undertaking a systematic review, you would need to search a wide range of sources

to locate all relevant research. If you are introducing evidence based practice and you can locate a systematic review that covers all the areas you need, a simple search of one resource will be sufficient.

SOURCES OF INFORMATION

A literature review will generally include searches of a range of sources of information. Some sources are more suited to particular questions and all cover slightly different topic areas. Familiarising yourself with your local health library and its resources is advisable and library staff can be invaluable in highlighting relevant sources and showing you how to use them. The National Electronic Library for Health (NeLH) [1] provides access to evidence based and discipline specific sources for all health professionals. Sources particularly useful in radiography and their advantages and disadvantages are highlighted below.

Books

Books provide useful background and overviews to topic areas. However, they can become quite dated. They may be useful in helping to focus on a topic area when embarking on a research project.

Journals

There are numerous journals available providing more up to date information. Journals can be peer reviewed (i.e. each article has been reviewed by experts in the field before publication) and these are often judged as higher quality. Some are evidence based, providing summaries and commentaries on research evidence. Radiography draws its professional knowledge base from an extremely wide evidence base — from physical sciences through clinical sciences to the social sciences. Consequently journals that are relevant to radiographers are numerous and span various disciplines and some are indicated in [Table 1](#).

Databases

Databases comprise records mainly of journal articles although some also provide details of books and reports. Databases are a good way of locating research literature, providing access to records over a wide range of years. However, they can be difficult to search. They are usually accessed via the Internet

Table 1 Examples of journals that may be relevant to radiographers

Radiography specific	Imaging modality specific	Physiology/pathology	Social science/psychology	General medicine	Evidence based
Radiography	Journal of Magnetic Resonance Ultrasound in Medicine and Biology Journal of X-Ray Science and Technology	Journal of Gastrointestinal Surgery Journal of Orthopaedic Research The Breast Bone and Joint	Social Science Psychology Social Science and Medicine Health Psychology	Journal of Emergency Nursing Journal of Infection Journal of Advanced Nursing	Evaluation Practice Evidence Based Healthcare

or your local library. A number of databases (known as the core collection) have recently been made available to all health professionals via the National Electronic Library for Health (NeLH) [1]. There are a large number of databases available that are relevant to healthcare professionals, each focusing on a slightly different topic area. Depending on your search question, you may need to search more than one. Those particularly relevant to radiographers are Medline (biomedical literature), Cinahl (nursing and allied health literature), Sociofile (sociology), Psychlit (Psychological literature), Cochrane Library (systematic reviews of evidence on a wide range of clinical areas, randomised controlled trials and the DARE database of systematic reviews produced by the NHS Centre for Reviews and Dissemination).

The Internet (World Wide Web)

The Internet is an international network of computer networks that allows access to a wealth of information from all over the world. Although there is vast potential for obtaining information via the Internet, it is unregulated and much of the information found may be unreliable. Searching (via search engines) can retrieve lots of information and it is important to appraise sites critically. A good looking web site is not an indicator of content quality. There are a wide range of reputable health related sites. These can be located via gateways (which check each site listed for quality), for example OMNI [2], NMAP [3] and the National Electronic Library for Health [1].

Professional organisations/societies

Professional organisations are often providers of profession specific information and research reports that can be useful in summarising information on particular topic areas. In some cases they also provide information services for members. Those most relevant to radiography include the College of Radiographers, the International Society for Magnetic Resonance in Medicine, Society of Radiologists in Ultrasound and the American Society of Radiologic Technologists. Often the most valuable sites for radiographic/radiological evidence are provided by medical societies and scientific medical organisations. Of particular interest is the American College

of Radiologists web site, which hosts numerous review papers on clinical conditions and the best [imaging] way to diagnose them and also treat them (using radiotherapy). Also worthy of note are specialist organisations such as the British and American Nuclear Medicine Society web sites and other sub-specialities such as ultrasound, magnetic resonance etc.

UNDERTAKING THE SEARCH

There are a number of basic techniques involved in undertaking a literature search. These are particularly suited to electronic database searching, however, once mastered, the skills can be transferred to any resource. It is important to remember to be systematic about your search; the following approach will help by breaking the search down into manageable components. A literature search should be an iterative (or a spiral) and not a linear process, and should be refined according to your results as you proceed. When examining your results, it is important to achieve a balance between sensitivity (the amount of information available on your topic area) and specificity (the amount of relevant information you retrieve), and the results must be manageable. However, if a search is to be comprehensive it is advisable to maximise sensitivity rather than specificity. The search can be broken down into a number of stages.

Stage 1: Focusing the search question

Part of planning the search involves focusing the search question. The clearer the question, the easier it is to undertake a search. Search questions are often too vague and could result in thousands of references—particularly in an area with a high volume of literature, e.g.

- I am looking for information on the role of radiography in the detection of cancer

In contrast, search questions can be too complicated or specific and result in too few references (depending on the volume of literature on the general topic area) or the searcher possibly being led to believe that nothing has been published on that particular subject.

- I am looking for information on the role of ultrasound as an adjunct to mammography in the detection of breast cancer in females who were referred for breast imaging because of palpable breast lumps or other abnormal findings on clinical examination

One method to help clarify your idea is to phrase your topic as a question.

In place of the above statement, you may have thought of something like this instead:

- How effective is ultrasound as an adjunct to mammography in the detection of breast cancer

Stage 2: Dividing the search into relevant concepts

It is then possible to divide your question into concepts that can be used as a basis for your search terms, for example

- How effective is ultrasound as an adjunct to *mammography* in the detection of *breast cancer*?

Or you could use the PICO method [4] that divides your question into discreet components based on the Population, Intervention, Comparison and Outcome that can be used later as building blocks for your search. For example for the question above:

Population: women with breast cancer
Intervention: ultrasound
Comparison: mammography
Outcome: improvement in detection rates

Words such as effective or management are difficult to search on and, because of their ambiguous nature, may retrieve a large number of irrelevant articles. If you are interested in the management of a particular condition, it is best to focus on the condition. If you are interested in finding out whether a treatment or procedure is effective, it is best to look for systematic reviews

(which summarise all available evidence) or randomised controlled trials (which evaluate whether a treatment or procedure is effective under certain conditions).

During the course of the search (based on the results retrieved) you may find yourself needing to modify your search question to make it more general or more specific. For example:

- How effective is *ultrasound* as an adjunct to *mammography* in the detection of *breast cancer* in patients with *palpable breast lesions*?

You may also wish to limit your search to certain types of studies, for example, systematic reviews or randomised controlled trials. This can be done using the concept model outlined above. For example:

- Are there any *systematic reviews* on the effectiveness of *ultrasound* as an adjunct to *mammography* in the detection of *breast cancer*?

Stage 3: Finding relevant terms for searching

Use the thesaurus (controlled list of terms) to identify the term used by that database to describe your topic of interest. Add the relevant terms to your strategy (check for tree, explosion and mapping features to help you use the thesaurus effectively). Searching on subject headings is the most effective way of retrieving most of the relevant information on your topic area. For example, headings arranged

in the thesaurus/hierarchy relevant for this search question is

Diagnostic imaging
Radiography
Mammography
...
Ultrasonography

Stage 4: Think of alternative synonyms

Think of alternative synonyms to describe your concepts. In some cases there are no suitable subject headings or if you wish to ensure you are being comprehensive then it is necessary to search on a range of terms or 'free text' in addition to a subject heading search. These could include radiographer, mammogram or ultrasound.

Stage 5: Combining your terms

Combine your concepts using the Boolean operators OR, AND. The operator OR is used to represent the union of a set (i.e. retrieves records with any term representing the same concept) and the term AND is used for the intersection of the sets (i.e. to combine different concepts). Stages 3–5 are represented as a Venn diagram in Fig. 2. This could be translated into the following simple (subject headings only) or more comprehensive search (subject headings and free text).

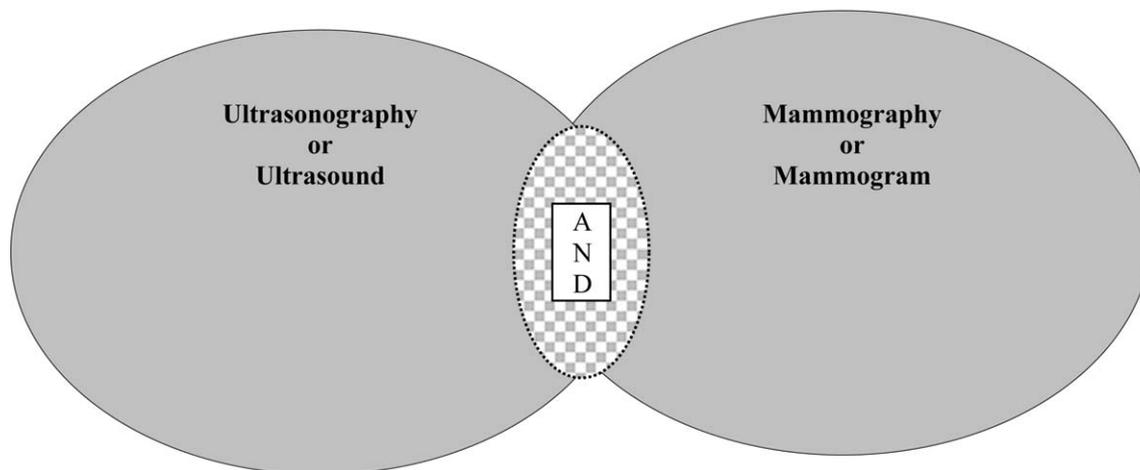


Figure 2 Venn diagram for search question: how effective is ultrasound as an adjunct to mammography.

Simple subject heading search	More comprehensive subject heading and free text search
1. Ultrasonography	1. Ultrasonography
2. Mammography	2. Ultrasound
3. Breast neoplasms	3. 1 or 2
4. 1 AND 2 AND 3	4. Mammography
	5. Mammogram
	6. 4 or 5
	7. Breast neoplasms
	8. Breast cancer
	9. 7 or 8
	10. 3 AND 6 AND 9

Stage 6: Reviewing and refining

Review your results and refine the strategy as necessary. This could include adding further synonyms or subject headings to focus the search or removing a term if it appears to be retrieving erroneous results. The limit function can also be used to restrict to particular languages or publication years. It is also possible to limit by publication type, these include systematic reviews and clinical trials—particularly useful if you are conducting an evidence based study.

In many systems it is possible to save your search strategies, and print, save or email your results. Saving your strategy is worthwhile, particularly if you wish to revisit at a later date.

MANAGING REFERENCES

It is very easy to become overwhelmed by the amount of references retrieved or lose track of the papers you have obtained or requested. It is therefore advisable to develop a system of managing references that works for you and allows you to keep track of your results and the papers that are relevant to your research. In the past researchers have used index cards to keep references and write notes or terms on these to help them find references quickly. There is now a wide range of reference management software packages available (e.g. Endnote and Reference Manager) that allow you to download directly from electronic sources and add in your own notes as applicable. An alternative method—particularly for a small project would be

to copy your references into a word processing package and annotate as appropriate.

WRITING THE LITERATURE REVIEW

Once you have completed your searches it is essential to draw this information together into the literature review. It is useful to describe your methods of obtaining the literature (e.g. sources searched and timescales and perhaps an indication of the search terms used). The purpose of the literature review is to examine relevant literature in the field with a view to summarising the important papers and giving an indication of how your study has developed from this previous work. A good literature review will involve critical evaluation of all the important scientific and clinical publications in the field. This will be covered in more detail in article 6 of the series.

A good literature review will read like a story. Initially the review should state the aims of the research to be undertaken, this provides a context for the papers to be reviewed. As well as discussing the relevant research findings, the review should, where appropriate, comment on the methodologies used, the shortcomings of the research, and suggest ways in which the studies might be improved. This latter point is particularly important if the present research is to build on that cited. As the review progresses and the different papers and articles are discussed, the hypotheses to be tested should gradually become apparent. The formulated hypotheses should not come as a surprise to the reader, rather they should be a logical derivation from the theory, evidence and commentary in the review.

Example

Consider a researcher who wants to examine the relative effectiveness of ultrasound as an adjunct to mammography in the diagnosis of breast cancer—what might a literature review look like in this type of study?

Firstly, the researcher might start by stating the aim—in effect the statement above. They would then have to introduce the concept of breast cancer, what is the relevant biology and physiology, imaging modalities? Relevant is the important word here—the review will not contain everything there is to know about breast cancer!

At some point the researcher needs to make it clear what they mean by 'effectiveness'—is it in terms of how sensitivity, specificity, effects on treatment or some other definition. How have these things been measured or operationalised in other studies?

What other work has been done which has looked at diagnosis of breast cancer—what methodologies did they use, were they adequate? Are there any studies, which have looked at the imaging modalities used in this study? What types of modalities have been researched in this context?

The review is trying to bring together all these items of evidence and comment, so that it all leads inexorably to the formulation of the hypotheses to be tested in the proposed study. Even in non-experimental studies, the review will have a similar structure—the only difference is that rather than formulating testable hypotheses, more broadly stated aims will be the result.

CONCLUSIONS

Undertaking a literature review is an essential component of the research process as it provides a rationale for your research, ideas for how to proceed or evidence on which to base your practice. Using a systematic approach to the search and a range of resources will ensure that you proceed on the basis of a sound knowledge base. This article has highlighted some relevant sources and techniques that become easier and familiar with training and practice. Help and further information are usually available on these issues from your local health library.

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FURTHER SOURCES OF INFORMATION

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