This Chapter is Draft Version 0.4

This Chapter is undergoing review, editing and formatting, and will not constitute the final agreed formal instructions for Cochrane Reviewers until this process is complete. However, the editors believe that this version is close enough to completion for it to be helpful and not to be seriously misleading, although reviewers should note that further sections, clarifications and some changes may still be added. It will be superseded by Version 1.0 in due course.

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7 Searching for studies

Chapter 7: Searching for studies

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Draft, 02 Jul 2008.

Key points

- We recommend that review authors work closely from the start with the Trials Search Co-ordinator of their Cochrane Review Group;
- We recommend that MEDLINE, EMBASE (if access is available to either the review author or Trials Search Co-ordinator) and the Cochrane Register of Diagnostic Test Accuracy Studies (when this is fully developed and available publicly) be searched as a minimum for all Cochrane systematic reviews of diagnostic test accuracy;
- We recommend that review authors also search for other related diagnostic test accuracy reviews (for example in MEDION, C-EBLM, ARIF, HTA database, DARE etc) to check references for additional relevant studies and reported search strategies for useful terms;
- Checking references of relevant studies (from the Cochrane review and other related reviews), together with citation searches, and the use of the 'related articles' feature in electronic databases, and 'citing alerts' in electronic journals, are important additional methods for identifying relevant studies;
- Searches should be designed to be highly sensitive, although this is likely to result in low precision;
- The search should reflect the key concepts of the review: (i) index test(s) and (ii) target condition will generally be the focus of the search, although this structure should be adapted to include other concepts if required to minimize the risk of missing relevant studies (e.g. (index test(s) or reference standard) and target condition);
- A wide variety of search terms, both text words and database subject headings (for example MeSH and EMTREE), should be used to describe each concept;
- Routine use of methodology search filters to identify diagnostic test accuracy studies should generally be avoided as currently even the most sensitive filters have been found to miss relevant studies and perform inconsistently across subject areas and study designs while at the same time not significantly reducing the number of studies that have to be assessed for inclusion.

7.1 Introduction

Conducting a comprehensive, objective and reproducible search for studies to determine the diagnostic accuracy of tests is a vital and challenging task in preparing a Cochrane systematic review of diagnostic test accuracy.

Cochrane Review Groups (CRGs) are responsible for providing assistance to review authors in identifying studies that are possibly relevant to their review. The majority of CRGs employ a dedicated Trials Search Co-ordinator (TSC) to provide this service (see Section 7.1.1.1). We recommend that review authors contact the TSC of their CRG before starting to search, in order to find out the level of support they provide. The information in this chapter is designed to assist authors wishing to undertake searches for studies under the guidance of a TSC or other information specialist, such as a local healthcare librarian, and to provide background information so that authors can gain a better understanding of the search process. We recommend that review authors work closely with the TSC or a designated local healthcare librarian in selecting sources to search and in developing and running search strategies for the review (see Sections 7.1.1.1 and 7.3.1.1).

The aim of the search strategy is to generate as comprehensive a list as possible of studies from the literature which may be suitable for answering the research question posed by the systematic review. The literature encompasses several types of published and unpublished material including journal articles, dissertations, editorials, conference proceedings and reports. Methods by which these sources can be found vary from searching electronic databases to handsearching journals and conference proceedings, checking reference lists of relevant publications, tracking citations of relevant studies and contacting experts.

Search strategies for identifying diagnostic studies are not restricted to a particular study design and are predominantly focused on terms for the diagnostic test(s) of interest (index test) and the clinical disorder or disease stage the test is seeking to detect (target condition). If further restriction of search results is required, we recommend exploring the use of additional topic specific terms first, before a methodology search filter for diagnostic test accuracy studies is considered (see Section 7.4.11). Ultimately, the introduction of specific subject headings terms (e.g. Publication Types) for diagnostic test accuracy studies in electronic databases should improve the efficiency of their retrieval.

This chapter is also designed to be useful to TSCs, who undertake searches on behalf of authors, to consult as a reference source.

This chapter outlines some general issues in searching for studies, describes a range of sources to search for diagnostic test accuracy studies, and discusses how to plan the search process, design and carry out sensitive search strategies, manage references found during the search process, and document and report the search process in the Cochrane protocol and review. This chapter also outlines the current empirical evidence on methodology search filters designed to improve the precision of database searches (see Section 7.4.11).

7.1.1 General issues

7.1.1.1 Role of the Trials Search Co-ordinator

The Trials Search Co-ordinator for each Cochrane Review Group is responsible for providing assistance to authors with searching for studies for inclusion in their reviews. The range of assistance varies according to the resources available to individual CRGs but may include some or all of the following: designing search strategies for the main bibliographic databases, running these searches in databases available to the CRG, saving search results and sending them to authors, advising authors on how to run searches in other databases and how to download results into their reference management software (see Section 7.5). We recommend that authors contact the TSC of their CRG before they start searching to find out the level of assistance offered.

If a CRG is currently without a TSC, we recommend that authors seek the guidance of a local healthcare librarian or information specialist, where possible one with experience of searching for systematic reviews.

Search assistance for TSCs is available from the CRG's regional support unit for Cochrane systematic reviews of diagnostic test accuracy (see Section 7.3.1.2).

7.1.1.2 Minimizing bias

Identifying as many relevant studies as possible and documenting the search for studies with sufficient detail so that it can be reproduced is largely what distinguishes a systematic review from a traditional narrative review and should help to minimize bias and assist in achieving more reliable estimates of diagnostic accuracy.

It is important to ensure that the process of identifying studies is as thorough and unbiased as possible (Easterbrook 1991; Dickersin 2005) and to be aware of the range of potential biases (Egger 1998) which might need to be addressed through a variety of search methods. Although the importance of publication bias in diagnostic studies is not yet fully explored (Song 2002), recent research indicates that to achieve as comprehensive a search as possible and thereby minimize the risk of bias, it is advisable to search several electronic databases (Whiting 2008a) and use other methods to retrieve studies (such as checking reference lists, citation searches, handsearching, contacting experts etc.) (Greenhalgh 2005).

A search of MEDLINE alone, is generally not considered adequate for systematic reviews and may lead to potential bias because of missed studies. Even if relevant records are in MEDLINE, it can be difficult to retrieve them easily (Golder 2006; Whiting 2008a). Relying exclusively on a MEDLINE search may retrieve a set of reports unrepresentative of all reports that would have been identified through a comprehensive search of several sources. For example, for reports of trials of therapeutic interventions there is some evidence that positive results are more likely to be published in English and any summary of only the English language reports can result in an overestimate of effectiveness due to language bias (Moher 1996; Egger 1997). More recent studies have shown that excluding studies published in languages other than English does not appear to bias estimates of effectiveness in conventional medicine reviews (Moher 2000; Jüni 2002; Egger 2003) but does result in bias for complementary and alternative medicine reviews (Moher 2003; Pham 2005).There is also evidence that intervention studies showing greater effectiveness are more likely to be published in scientific journals, while studies with less positive results end up unpublished in file drawers, meeting abstract books, or report literature, hence if the latter sources are not included in the search for relevant studies, publication bias can lead to an overestimate of effectiveness (Begg 1988; Easterbrook 1991; Song 2000; Hopewell 2007b).

Further research is needed to determine whether positive results in diagnostic accuracy studies follow a similar publication pattern and are at risk of language and other reporting biases (Song 2002). Studies on diagnostic accuracy often are based on routinely collected data, so publication bias may be more prevalent in diagnostic than in therapeutic research (Irwig 1995). Results of studies that are never published may well remain unknown. Searching for studies in languages other than English and for studies that are difficult to locate (grey literature) such as conference proceedings, various types of reports, ongoing studies etc., may be necessary to gain a more complete overview and to get an idea about the size and direction of any publication bias in diagnostic research.

7.1.1.3 Copyright legislation and database licensing agreements

It is Cochrane Collaboration policy that all review authors and others involved in the Collaboration adhere to copyright legislation and the terms of database licensing agreements.

In the context of searching for studies, this refers in particular to adhering to the terms and conditions of use when searching databases and downloading records and adhering to copyright legislation when obtaining copies of articles. We recommend that review authors seek guidance on this from their Trials Search Co-ordinator or local healthcare librarian, as copyright legislation varies across jurisdictions and licensing agreements across institutions.

7.1.2 Summary points

- We recommend that Cochrane review authors seek advice from the Trials Search Co-ordinator of their Cochrane Review Group before starting a search;
- If the Cochrane Review Group is currently without a Trials Search Co-ordinator, we recommend that authors seek the guidance of a local healthcare librarian or information specialist, where possible one with experience of searching for systematic reviews;
- A search of MEDLINE alone may result in missed studies;
- We recommend that review authors consider searching a range of databases, combined with other methods such as checking reference lists, or conducting citation searches, and they may wish to consider handsearching journals or conference proceedings to retrieve relevant studies;
- The importance of publication bias in studies of diagnostic test accuracy is not yet fully explored;
- It is Cochrane Collaboration policy that all review authors and others involved in the Collaboration adhere to database licensing terms and conditions of use and copyright legislation.

7.2 Sources to search

7.2.1 Bibliographic databases

7.2.1.1 Bibliographic databases – general introduction

A search for relevant studies generally begins with health-related bibliographic databases. Some bibliographic databases, such as MEDLINE and EMBASE, include abstracts for the majority of recent records. A key advantage of these databases is that they can be searched electronically both for words in the title and abstract (where available) and by using the subject headings, assigned to each record by database indexers (see Section 7.4.5).

Thousands of electronic bibliographic databases exist. A comprehensive guide to over 15,500 databases, the 'Gale Directory of Online Portable and Internet Databases' (http://library.dialog.com/bluesheets/pdf/bl0230.pdf), may be accessible from your local institution's library. We recommend that authors seek advice from the Trials Search Co-ordinator of their Cochrane Review Group on database selection. Some databases, such as MEDLINE and EMBASE, cover a wide range of areas of health care and index journals published from around the world, mostly in English. Other databases, such as the Australasian Medical Index, the Chinese Biomedical Literature Database, and the Latin American Caribbean Health Sciences Literature (LILACS) index journals published in specific regions of the world. Others focus on specific areas of health care, such as the Cumulative Index to Nursing and Allied Health (CINAHL), or on special document types (ISI Proceedings focuses on conferences, for example).

The Cochrane Collaboration is developing an electronic database of diagnostic test accuracy studies similar to the Cochrane Central Register of Controlled Trials (CENTRAL) published in *The Cochrane Library*. This project is at an early stage, and is not yet publicly available; it will take time before the register evolves into the essential resource it is intended to be for the Collaboration (see Sections 7.2.1.2 and 7.3.1.3).

Databases are available to individuals for a fee on a subscription or on a 'pay-as-you-go' basis. They are also available free at the point of use through national provisions, site-wide

licences at institutions such as universities or hospitals, through professional organizations as part of their membership packages, or free of charge on the internet.

There are also several international initiatives to provide free or low-cost online access to databases (and full-text journals) over the internet. The Health InterNetwork Access to Research Initiative (HINARI) provides access to a wide range of databases and nearly 4000 major journals from a wide range of publishers in biomedical and related social sciences, for healthcare professionals in local, not-for-profit institutions in over 100 low-income countries:

- www.who.int/hinari/en/

The International Network for the Availability of Scientific Publications (INASP) also provides access to a wide range of databases and journals. Journal titles available vary by country. For further details see:

- www.inasp.info/file/68/about-inasp.html

Electronic Information for Libraries (eIFL) is a similar initiative based on library consortia to support affordable licensing of journals in 50 low- to middle-income countries in central, eastern and south-east Europe, the former Soviet Union, Africa, the Middle-East and south-east Asia:

- www.eifl.net/cps/sections/about

For more detailed information about how to search these and other databases refer to Section 7.4.

7.2.1.2 Cochrane Register of Diagnostic Test Accuracy Studies

The Cochrane Register of Diagnostic Test Accuracy Studies (CRDTAS) is a new initiative, with initial development funding from the Screening and Test Evaluation Program, School of Public Health, University of Sydney, Australia, and The Cochrane Collaboration. It is being developed and managed at the Cochrane Renal Group editorial base in Sydney, Australia, with the assistance of a small reference group with expertise in searching for and screening diagnostic test accuracy studies. These include members of the regional support units for Continental Europe and the UK (see Section 7.3.1.2), and of members of the Cochrane Information Retrieval Methods Group. It is not yet publicly available for searching.

It is intended to provide a resource for Cochrane Review Groups supporting authors who are undertaking diagnostic reviews, to provide a mechanism for the re-tagging of diagnostic test accuracy studies in MEDLINE with a suitable Publication Type (in order to provide a more efficient search method for identifying relevant studies), and to provide a resource for methodological research into these studies. It is intended that eventually it will become the diagnostic test accuracy studies equivalent of the Cochrane Central Register of Controlled Trials (CENTRAL) published in *The Cochrane Library*.

For a more detailed description of how the Register is being developed, refer to Section 7.3.1.3.

7.2.1.3 MEDLINE and EMBASE

MEDLINE, the US National Library of Medicine's database of citations and abstracts in the fields of medicine, nursing, dentistry, veterinary medicine, healthcare systems and preclinical sciences, currently contains over 16 million references to journal articles from the 1950s onwards. Currently 5000 journals in 37 languages are indexed for MEDLINE:

- www.nlm.nih.gov/pubs/factsheets/medline.html

PubMed provides access to a free version of MEDLINE that also includes up-to-date citations not yet indexed for MEDLINE:

- www.nlm.nih.gov/pubs/factsheets/pubmed.html

In addition, PubMed includes records from journals that are not indexed for MEDLINE and records considered 'out-of-scope' from journals that are partially indexed for MEDLINE. For further information about the differences between MEDLINE and PubMed see:

- www.nlm.nih.gov/pubs/factsheets/dif_med_pub.html.

A particularly useful feature of PubMed is that a list of 'related articles' can be obtained for each relevant record identified (see also Sections 7.2.1.6 and 7.2.2.2). PubMed also provides links to full-text versions of articles, where available, on other publishers' websites.

MEDLINE is also available on subscription from a number of online database providers, such as Ovid. Access is usually free to members of the institutions paying the subscriptions, hospitals and universities, for example.

The US National Library of Medicine (NLM) has developed the NLM Gateway, which allows users to search MEDLINE or PubMed together with other NLM resources simultaneously, such as the Health Services Research Projects database (HSRProj), Meeting Abstracts and the TOXLINE subset for toxicology citations:

- gateway.nlm.nih.gov/gw/Cmd

EMBASE, a biomedical database published by Elsevier, currently contains over 12 million records from 1974 onwards. Currently 4,800 journals are indexed for EMBASE in 30 languages:

- http://www.info.embase.com/embase_suite/about/brochures/embase_fs.pdf

EMBASE.com is Elsevier's own version of EMBASE that, in addition to the 12 million EMBASE records from 1974 onwards, also includes over 7 million unique records from MEDLINE from 1966 to date, thus allowing both databases to be searched simultaneously:

- http://www.info.embase.com/embase_com/about/index.shtml

In 2007, Elsevier launched EMBASE Classic which now provides access to records digitized from the Excerpta Medica print journals (the original print indexes from which EMBASE was created) from 1947 to 1973:

- www.info.embaseclassic.com/pdfs/factsheet.pdf

EMBASE is only available by subscription. We recommend that authors check if their Cochrane Review Group has access and, if not, whether it is available through their local institution's library.

Database overlap

Of the 4,800 journals indexed in EMBASE, 1,800 are not indexed in MEDLINE. Similarly, of the 5,200 journals indexed in MEDLINE, 1,800 are not indexed in EMBASE:

- http://www.info.embase.com/embase_suite/about/brochures/embase_fs.pdf

There is evidence of the value of searching EMBASE in addition to MEDLINE for systematic reviews of interventions as records uniquely identified in EMBASE have been shown to make a contribution to the overall estimate of effectiveness (Sampson 2003), which may be attributed in part to its coverage of languages other than English. The size of the contribution may vary considerably – the overlap of EMBASE and MEDLINE has been estimated to be approximately 34% (Smith 1992) and in terms of volume of records to range from 10% to 87% depending on the topic under investigation (Kleijnen 1992; Ramos-Remus 1994; Royle 2005). Searchers comparing the databases have concluded that relevant studies would be missed if only MEDLINE were searched for diagnostic test accuracy studies (Fraser 2006; Whiting 2008a) and for intervention studies in a variety of medical specialties (Brazier 1999; McDonald 1999; Topfer 1999; Minozzi 2000; Suarez-Almazor 2000; Savoie 2003; Royle 2005).

An overview (Glanville 2007) of recent research (Fraser 2006; Whiting 2008a) reveals that MEDLINE and EMBASE are good sources of diagnostic test accuracy studies. Whiting and colleagues (2008) examined the value of searching a wide range of databases and additional sources in identifying diagnostic test accuracy studies for inclusion in systematic reviews. They analysed eight diagnostic reviews which had used extensive, well-documented literature searches not further limited by diagnostic search filters to retrieve 522 included studies. They searched for the included studies in MEDLINE, EMBASE, BIOSIS, Science Citation Index, LILACS, PASCAL and CENTRAL. For each review and each database they calculated the proportion of studies identified by the search and the proportion of studies indexed in the database. They found that searches retrieved almost twice as many records from MEDLINE as from any other database. A greater proportion of included studies were in MEDLINE and identified by searches of MEDLINE than from any other database. None of the searches in a specific database identified all the studies included in a review. For the majority of the reviews EMBASE, Science Citation Index and BIOSIS all contained relevant studies that were not included in MEDLINE. Although searching LILACS did not identify many relevant studies overall, those identified were often not in any of the other databases but the number needed to be read (NNR) to find one relevant study was the highest of all the databases. Over 20% of the studies included in the reviews were not identified by searching MEDLINE. Thirty studies (6%) included in the eight systematic reviews were not identified by the electronic searches.

Fraser and colleagues (2006) assessed the contribution of MEDLINE and EMBASE searches for diagnostic test accuracy studies in glaucoma screening. Extensive subject searches of a range of databases and full-text searching of selected ophthalmology journals were conducted and 100 included studies were identified. MEDLINE and EMBASE searches provided 97 of these 100 included studies.

This latest empirical evidence reveals that MEDLINE and EMBASE are good sources of diagnostic test accuracy studies but searching MEDLINE alone misses relevant studies (range: 13% to 36%, Whiting 2008a). We recommend that a range of databases be considered for searching but Whiting and colleagues found little additional benefit from searching PASCAL and CENTRAL. Even very sensitive search strategies may miss a significant proportion of relevant studies indexed in general biomedical databases and so additional methods to identify studies, such as checking references (see Section 7.2.2.1), citation searches of relevant studies (see Sections 7.2.1.6 and 7.2.2.2), handsearching (see Section 7.2.2.3) and searching grey literature sources (see Section 7.2.1.8) such as report literature, dissertations (see Section 7.2.1.7), conference abstracts (see Sections 7.2.1.8 and 7.2.2.6) and other difficult to locate studies may need to be considered.

7.2.1.4 National and regional databases

In addition to MEDLINE and EMBASE, which are generally considered to be major international general healthcare databases, many countries and regions produce electronic

bibliographic databases that concentrate on the literature produced in these regions, and which often include journals and other literature not indexed elsewhere. Access to many of these databases is available free of charge on the internet. Others are only available by subscription or on a 'pay-as-you-go' basis. Indexing complexity and consistency varies, as does the sophistication of the search interface, but they can be an important source of additional studies from journal articles not indexed in other international databases such as MEDLINE or EMBASE. Some examples are included in Box 7.2.a. When supplementing a search of MEDLINE and EMBASE with searching databases from other regions, where the prevalence of the target condition of interest in the population may be markedly different, it may be particularly important for authors of diagnostic test accuracy reviews to consider possible sources of publication bias. Disease prevalence has been shown to influence measures of test accuracy (Leeflang 2008a; Leeflang 2008b) and so test accuracy studies published in countries with higher prevalence of the target condition with a potentially more severely diseased population, may be consistently different from test accuracy studies published in countries where prevalence is lower and these differences will need to be reported to minimize bias from entering the analysis of the results of the studies.

Box 7.2.a: Examples of regional electronic bibliographic databases

Africa: African Index Medicus

- indexmedicus.afro.who.int/

Australia: Australasian Medical Index (fee-based)

- www.nla.gov.au/ami/

China: Chinese Biomedical Literature Database (CBM) (in Chinese)

- www.imicams.ac.cn/cbm/index.asp

Eastern Mediterranean: Index Medicus for the Eastern Mediterranean Region

- www.emro.who.int/HIS/VHSL/Imemr.htm

Europe: PASCAL (fee-based)

- international.inist.fr/article21.html

India: IndMED

- indmed.nic.in/

Korea: KoreaMed

- www.koreamed.org/SearchBasic.php

Latin America and the Caribbean: LILACS (in English, Spanish and Portuguese)

- bases.bireme.br/cgi-bin/wxislind.exe/iah/online/?IsisScript=iah/iah.xis&base=LILACS&lang=i

South-East Asia: Index Medicus for the South-East Asia Region (IMSEAR)

- library.searo.who.int/modules.php?op=modload&name=websis&file=imsear

Ukraine and the Russian Federation: Panteleimon

- www.panteleimon.org/maine.php3

Western Pacific: Western Pacific Region Index Medicus (WPRIM)

- wprim.wpro.who.int/SearchBasic.php

7.2.1.5 Subject-specific databases

Which subject-specific databases to search in addition to MEDLINE, EMBASE and the Cochrane Register of Diagnostic Test Accuracy Studies (when it becomes publicly available) will be influenced by the topic of the review, and access to specific databases. Most of the

main subject-specific databases are available only on a subscription or 'pay-as-you-go' basis. Access to databases is therefore likely to be limited to those databases that are available to the Trials Search Co-ordinator at the Cochrane Review Group editorial base and those that are available at the institutions of the review authors. A selection of the main subject-specific databases that are more likely to be available through institutional subscriptions (and therefore 'free at the point of use') or are available free of charge on the internet are listed in Box 7.2.b, together with web addresses for further information. Access details vary according to institution. Review authors can seek advice from their local healthcare librarian for access at their institution.

In addition to subject-specific databases, general search engines include:

- Google Scholar (free on the internet):
    - scholar.google.com/advanced_scholar_search
- Intute (free on the internet):
    - www.intute.ac.uk/
- Turning Research into Practice (TRIP) database (evidence-based healthcare resource) (free on the internet):
    - www.tripdatabase.com/

Box 7.2.b: Examples of subject-specific electronic bibliographic databases

Biology and chemistry

- Biological Abstracts / BIOSIS Previews:
    - www.biosis.org/
- Chemical Abstracts:
    - www.cas.org/
- Database of the International Federation of Clinical Chemistry and Laboratory Medicine Committee for Evidence-based Laboratory Medicine (IFCC C-EBLM database) (contact j.watine@ch-rodez.fr)

International health

- Global Health:
    - www.cabi.org/datapage.asp?iDocID=169

Nursing and allied health

- Allied and Complementary Medicine (AMED):
    - www.bl.uk/collections/health/amed.html
- British Nursing Index (BNI):
    - www.bniplus.co.uk/
- Cumulative Index to Nursing and Allied Health (CINAHL):
    - www.cinahl.com/

Primary care

- Essential Evidence Plus (formerly Patient Oriented Evidence that Matters (InfoPOEMs)):
    - www.essentialevidenceplus.com/

Social science, psychology and psychiatry

- Applied Social Sciences Index and Abstracts (ASSIA):
    - www.csa.com/factsheets/assia-set-c.php
- PsycINFO:
    - www.apa.org/psycinfo/
- Sociological Abstracts:
    - www.csa.com/factsheets/socioabs-set-c.php

7.2.1.6 Citation indexes – forward citation tracking and 'related articles' feature

The Science Citation Index / Science Citation Index Expanded, published by Thomson Reuters, is a database that lists published articles from nearly 6000 major scientific, technical and medical journals and links them to articles in which they have been cited since publication. It requires a subscription and is available online as SciSearch and on the internet as Web of Science. Web of Science is also incorporated in Web of Knowledge. A similar database exists for the social sciences known as Social Sciences Citation Index.

The Science Citation Index can be used to identify studies for the review by first conducting a subject search, as in other electronic database searching, using a combination of search terms appropriate to this database. After screening the results from all the electronic databases searched and identifying a set of relevant studies for inclusion in the review, these relevant studies can also be searched for in the Science Citation Index and then, using the option for a citation search, articles citing these original relevant studies can be checked to see if any of these additional articles are also relevant for the review. It is a way of searching forwards in time from the publication of a relevant study to identify additional relevant articles published since then. Citation searching is an important and effective adjunct to database searching and handsearching (Greenhalgh 2005; Whiting 2008a). Information about these citation indexes is available at:

- Science Citation Index:
    - scientific.thomson.com/products/sci/
- Social Sciences Citation Index:
    - scientific.thomson.com/products/ssci/
- Web of Science:
    - scientific.thomson.com/products/wos/
- Web of Knowledge:
    - isiwebofknowledge.com/

In 2004, Elsevier launched an abstract and citation database – Scopus. Scopus covers 15,000 journals (of which 1000 are open access journals) and 500 conference proceedings. It contains over 30 million abstracts and results from nearly 400 million scientific web pages:

- Scopus:
    - info.scopus.com/overview/what/

Google Scholar (www.scholar.google.com) and Elsevier's Scopus (www.scopus.com/) are helpful additional sources to the Web of Science citation indexes for cited or citing studies (Kloda 2007). Authors can also use the relevant studies identified for the review as 'seeds' to conduct searches for additional citations using the 'related articles' or 'find similar' features in PubMed and Ovid (respectively), for example, to identify studies with a large overlap of references with the relevant studies or which have been assigned some of the same database subject headings or contain some of the same text words as the relevant studies.

7.2.1.7 Dissertations and theses databases

Some studies have found that dissertations and theses are more likely to be published in full if results are positive (Smart 1964; Vogel 2000; Zimpel 2000) and that, on average, dissertations that remain unpublished have lower effect sizes than the published literature (Smith 1980). It is not yet known whether dissertations in diagnostic test accuracy follow a similar publication pattern but to minimize possible effects of publication bias, authors may wish to consider searching for dissertations and theses. These are not normally indexed in general bibliographic databases such as MEDLINE or EMBASE but there are exceptions, such as CINAHL, which indexes nursing dissertations and PsycINFO which indexes dissertations relevant to psychology and psychiatry. Some examples of databases that index published and unpublished dissertations and theses are included in Box 7.2.c:

Box 7.2.c: Examples of dissertations and theses databases

- ProQuest Dissertations & Theses Database: indexes more than two million doctoral dissertations and masters' theses and includes US dissertations since 1861 and British dissertations since 1988:
    - www.proquest.co.uk/products_pq/descriptions/pqdt.shtml
- Index to Theses in Great Britain and Ireland: lists over 500,000 theses since 1716:
    - www.theses.com/
- DissOnline: indexes 50,000 German dissertations:
    - www.dissonline.de/

7.2.1.8 Grey literature databases

Grey literature is generally understood to mean literature that is not formally published in accessible sources such as books or journal articles. Conference abstracts and other grey literature have been shown to be sources of approximately 10% of the studies referenced in Cochrane reviews of interventions (Mallett 2002). Grey literature (including conference abstracts) has been found to be more likely to contain intervention studies reporting non-significant results than those published in healthcare journals (McAuley 2000; Hopewell 2005; Hopewell 2007b). Thus, failure to identify and include studies reported in conference proceedings and other grey literature sources, may affect the results or threaten the validity of a systematic review of interventions. Further research is needed to determine whether reports of diagnostic accuracy studies presented at conferences and in other grey literature sources follow a similar pattern (Brazzelli 2006; Brazzelli 2008). Databases covering grey literature sources include:

OpenSIGLE

EAGLE (the European Association for Grey Literature Exploitation) has closed the SIGLE (System for Information on Grey Literature) database, which was one of the most widely-used databases of grey literature. INIST-CNRS in France (Institute for Scientific and Technical Information – National Centre for Scientific Research) has launched OpenSIGLE, which provides access to all the former SIGLE records, new data added by EAGLE members and information from Greynet:

- opensigle.inist.fr

National Technical Information Service (NTIS):

NTIS provides access to the results of both US and non-US government-sponsored research from 1964 and can provide the full text of the technical report for most of the results retrieved. NTIS is free on the internet:

- www.ntis.gov/

Conference abstracts are an important source of grey literature and are covered in Section 7.2.2.6.

7.2.2 Journals and other non-bibliographic-database sources

Searching in electronic databases using an adequate combination of text words and subject headings (database indexing terms) is the start of the search for relevant studies, but only a proportion of relevant studies can be identified in this way (Dickersin 1994; Hopewell 2002; McDonald 2002; Hopewell 2003; Greenhalgh 2005; Whiting 2008a). Further useful strategies might include checking reference lists of relevant studies and other reviews and guidelines (see Section 7.2.2.1), citation searches of relevant studies (see Sections 7.2.1.6 and 7.2.2.2), handsearching (see Section 7.2.2.3) and trying to identify unpublished studies (see Section 7.2.3).

7.2.2.1 Other reviews, guidelines and reference lists as sources of studies

Checking the reference lists of primary studies (particularly those identified for inclusion in the review) and of existing reviews and meta-analyses is an effective method of identifying additional studies (Greenhalgh 2005). In a recent study, Whiting and colleagues (2008a) found that the majority of relevant diagnostic accuracy studies that had not been found by database searching, or that were included in databases but not retrieved by the database searches, were identified by checking reference lists. Reference lists can provide primary diagnostic studies included in a review as well as excluded studies, previously published reviews on the subject, relevant editorials or discussion papers and publications on closely related topics (Devillé 2002a; Devillé 2002b).

Some of the most convenient sources of references to potentially relevant studies are existing reviews. Bayliss and Davenport (2008) compare five specialist review databases for locating systematic reviews of diagnostic studies (MEDION (University of Maastricht, the Netherlands and University of Leuven, Belgium), DARE and HTA database (Centre for Reviews and Dissemination, University of York, UK), C-EBLM (International Federation of Clinical Chemistry), and the Aggressive Research Intelligence Facility (ARIF) database (Department of Public Health, Epidemiology and Biostatistics, University of Birmingham, UK). In their recent analysis of the content of these five databases, Davenport and Bayliss (2008) conclude that a large degree of overlap exists between the databases and that MEDION contains the highest number of test accuracy reviews unique to a database (n=328). Topic areas covered include obstetrics and gynaecology (18%: range 8% to 18%), cardiology (15%: range 6% to 14%) and gastro-intestinal disease (9%: range 8% to 14%). Ophthalmology is most prominent in MEDION (11% of citations), infectious disease and haematology in C-EBLM, and genetic testing in the HTA database (12%). The majority of reviews (85%) were concerned with estimation of test accuracy. C-EBLM database contained a larger proportion of reviews concerned with early test development in contrast to other databases where test accuracy was evaluated in a clinical setting. The majority of reviews evaluated tests in secondary and screening settings. Only 4% of reviews evaluated tests for use in primary care (range 1% to 6%).

Cochrane systematic reviews of diagnostic test accuracy are published in the *Cochrane Database of Systematic Reviews* in *The Cochrane Library* (www.thecochranelibrary.com). Other sources of diagnostic reviews include:

Aggressive Research Intelligence Facility (ARIF)
The ARIF database, produced by the Department of Public Health, Epidemiology and Biostatistics, University of Birmingham, UK, currently contains over 800 reviews of diagnostic research which are coded under the keyword DIAGNOSIS. This database is updated daily and is available free of charge on the ARIF website:

- www.arif.bham.ac.uk/

Database of Abstracts of Reviews of Effects (DARE)
The Database of Abstracts of Reviews of Effects (DARE), produced by the Centre for Reviews and Dissemination (CRD) at the University of York, UK, currently contains quality assessments in the form of structured abstracts of almost 5000 systematic reviews, including approximately 500 diagnostic reviews. This database is published and updated quarterly in *The Cochrane Library*; the most recent version, updated more frequently, is available free of charge on the CRD website:

- www.york.ac.uk/inst/crd/crddatabases.htm#DARE

Health Technology Assessments Database (HTA Database)
The HTA Database, produced by the Centre for Reviews and Dissemination (CRD) at the University of York, UK, currently contains approximately 400 systematic diagnostic evaluations. This database is published and updated quarterly in *The Cochrane Library*; the most recent version, updated more frequently, is available free of charge on the CRD website:

- www.york.ac.uk/inst/crd/crddatabases.htm#HTA

CRD used to produce the CRD Ongoing Reviews Database which was searchable through the UK National Research Register (NRR) but since that was archived in September 2007, records of ongoing reviews have been transferred to the HTA Database.

International Federation of Clinical Chemistry and Laboratory Medicine Committee for Evidence-based Laboratory Medicine database (C-EBLM database)
This database currently contains over 550 systematic reviews of diagnostic studies published in the English language (contact j.watine@ch-rodez.fr)

MEDION – Meta-analyses van Diagnostisch Onderzoek
The MEDION database is produced and continuously updated by a small group of researchers at the Departments of General Practice of the Universities of Maastricht (the Netherlands) and Leuven (Belgium). Currently it contains over 1000 references to systematic reviews and methodological studies on diagnosis and screening and is available free of charge from the following website:

- www.mediondatabase.nl

Reviews and guidelines may also provide useful information about the search strategies used in their development: see Box 7.2.d. Specific evidence-based search services such as Turning Research into Practice (TRIP) can be used to identify reviews and guidelines. For the range of systematic review sources searched by TRIP see:

- www.tripdatabase.com/Aboutus/Publications/index.html?catid=11

and for guidelines see:

- www.tripdatabase.com/Aboutus/Publications/index.html?catid=4

MEDLINE, EMBASE and other bibliographic databases

MEDLINE, EMBASE and other bibliographic databases can also be searched to identify review articles and guidelines. In MEDLINE, the most appropriate review articles should be indexed under the Publication Type terms 'Meta-analysis', which was introduced in 1993, or 'Review', which was introduced in 1966. Guidelines should be indexed under the Publication Type term 'Practice Guideline', which was introduced in 1991. EMBASE also has a subject heading 'Systematic Review', which was introduced in 2003, and 'Practice Guideline', which was introduced in 1994.

In PubMed there is a 'Systematic Review' search strategy or filter under the 'Clinical Queries' link:

- www.ncbi.nlm.nih.gov/entrez/query/static/clinical.shtml

It is very broad in its scope and is described as follows: "This strategy is intended to retrieve citations identified as systematic reviews, meta-analyses, reviews of clinical trials, evidence-based medicine, consensus development conferences, guidelines, and citations to articles from journals specializing in review studies of value to clinicians."

- www.nlm.nih.gov/bsd/pubmed_subsets/sysreviews_strategy.html

Search filters have been developed and validated to identify systematic reviews in MEDLINE (Boynton 1998; Shojania 2001; White 2001; Montori 2005; National Library of Medicine 2007), EMBASE (Wilczynski 2007; Wong 2006a) and CINAHL (Wong 2006b).

A useful resource of methodological search filters (validated as well as pragmatic) for a variety of study designs, including systematic reviews, has been compiled and is updated regularly by the UK InterTASC Information Specialists' Subgroup (ISSG):

- www.york.ac.uk/inst/crd/intertasc/sr.htm

A useful recent addition to the ISSG Search Filter Resource website are structured abstracts and critical appraisals of the search filters listed.

Although checking reference lists of relevant studies is an efficient means of identifying additional studies for possible inclusion in a review, and therefore should be used as an adjunct to other search methods, authors should also be aware that investigators may selectively cite studies with positive results (Gøtzsche 1987; Ravnskov 1992; Ravnskov 1995; Kjaergard 2002). Research is needed to determine whether authors of diagnostic studies follow a similar pattern of behaviour.

Box 7.2.d: Examples of evidence-based guidelines

- Australian National Health and Medical Research Council: Clinical Practice Guidelines:
  - www.nhmrc.gov.au/publications/subjects/clinical.htm
- Canadian Medical Association – Infobase: Clinical Practice Guidelines:
  - www.cma.ca/index.cfm/ci_id/54316/la_id/1.htm
- National Guideline Clearinghouse (US):
  - www.guideline.gov/
- National Library of Guidelines (UK):
  - www.library.nhs.uk/guidelinesFinder/
- New Zealand Guidelines Group:
  - www.nzgg.org.nz
- NICE Clinical Guidelines (UK):
  - www.nice.org.uk/aboutnice/whatwedo/aboutclinicalguidelines/about_clinical_guidelines.jsp

7.2.2.2 Citation alerts

In addition to going back in time by checking references in retrieved studies, there is also an opportunity to search forward in time. As well as searching citation indexes and using the 'related articles' or 'find similar' feature in PubMed and Ovid, for example, to identify studies with a large overlap in references with the relevant study or which have been assigned some of the same database subject headings or contain some of the same text words as the relevant study (see Section 7.2.1.6), there are options to receive 'citation alerts' from other non-database sources. Some journals (e.g. the *BMJ*) which are published on the internet, offer an option to be 'alerted', via e-mail or RSS feed, whenever a particular article is cited. Citation searches and alerts can be useful for identifying additional studies that might be relevant for the review.

7.2.2.3 Handsearching

Authors may wish to consider handsearching journals or conference proceedings in their subject area to identify studies for their review, particularly those not indexed in the major databases. Handsearching involves a manual page-by-page examination of the entire contents of a journal issue or conference proceedings to identify eligible reports of studies for a review. In journals, they may appear in articles, abstracts, news columns, editorials, letters or other text. Handsearching may prove a useful additional search method: firstly, not all diagnostic studies are included in electronic bibliographic databases (Whiting 2008a), and articles in some parts of journals (such as supplements and correspondence) are not routinely indexed in databases such as MEDLINE (Hopewell 2002; Hopewell 2007a). Secondly, even if reports of diagnostic accuracy studies are included in databases, they may not be indexed with terms that allow them to be easily identified as such (van der Weijden 1997; Vincent 2003), and

incomplete reporting by authors may also make relevant studies difficult to identify when screening the titles and abstracts (where available) of electronic bibliographic records (Fraser 2006). Authors who wish to handsearch journals or conference proceedings should consult their Trials Search Co-ordinator, who can register the search on the Collaboration's Master Lists for journals and conference proceedings (see below).

Trials Search Co-ordinators may wish to help populate the Cochrane Register of Diagnostic Test Accuracy Studies by handsearching journals within the scope of their Group that are likely to yield diagnostic studies and send those they identify to Ruth Mitchell, Trials Search Co-ordinator for the Cochrane Renal Group, who is managing the centralized Register (ruthm4@chw.edu.au). To identify candidate journals Trials Search Co-ordinators may wish to undertake a preliminary scoping study by searching MEDLINE and EMBASE in a topic area combined with methodological terms such as the subject heading 'Sensitivity and Specificity' (exploded), as well as the text words (sensitiv$ and specific$), or use the Clinical Queries option for diagnosis in PubMed (which can be optimized for specificity or sensitivity), to determine which journals appear to be associated with the most retrieved citations. They may also wish to monitor in which journals the included studies from the Group's reviews are published and consider journals not indexed in MEDLINE or EMBASE for handsearching. The value of handsearching journals in addition to conducting sensitive electronic searches in a range of databases to identify diagnostic test accuracy studies is not yet clear.

The US Cochrane Center oversees prospective registration of all potential handsearching and maintains files of handsearching activity on behalf of the Collaboration in the Master List (Journals) and the Master List (Conference Proceedings) (see apps1.jhsph.edu/Cochrane/masterlist.asp). All correspondence regarding the initiation, progress and status of a journal or conference proceedings search should be between the Cochrane Review Group Trials Search Co-ordinator and staff at the US Cochrane Center.

7.2.2.4 Full-text journals available electronically

Most academic institutions subscribe to a wide range of electronic journals and make these available free of charge at the point of use to their members. Review authors can seek advice about access to electronic journals from the library service at their local institution. Some professional organizations provide access to a range of journals as part of their membership package. In some countries similar arrangements exist for health service employees through national licences. There are also international initiatives to provide free or low-cost online access to full-text journals (and databases) over the internet, including the Health InterNetwork Access to Research Initiative (HINARI), the International Network for the Availability of Scientific Publications (INASP) and Electronic Information for Libraries (eIFL) (see Section 7.2.1.1).

Examples of some full-text journal sources that are available worldwide free of charge without subscription are given in Box 7.2.e.

As well as providing a convenient method for retrieving the full article of studies identified as relevant, full-text journals can also be searched electronically in a similar way to electronic bibliographic databases, depending on the search interface. It is, however, important to specify if the full text of a journal has been searched electronically as some journals omit sections of the print version, for example letters, from the electronic version and some include extra articles in electronic format only. It is also recommended that a local electronic copy or print copy be taken of any potentially relevant article found electronically as the journal may cease publication, or change publishers, and free access may cease.

Box 7.2.e: Examples of full-text journal sources available worldwide without charge

- BiomedCentral:
  - www.biomedcentral.com/browse/journals/
- Public Library of Science (PLoS):
  - www.plos.org/journals/
- PubMed Central:
  - www.pubmedcentral.nih.gov/

Websites listing journals offering free full-text access include:

- Free Medical Journals:
  - freemedicaljournals.com/
- HighWire Press:
  - highwire.stanford.edu/lists/freeart.dtl

7.2.2.5 Tables of contents

Many journals, even those that are available by subscription only, offer Table of Contents (TOC) services free of charge, usually through e-mail alerts or RSS feeds. In addition, a number of organizations offer TOC services (see Box 7.2.f)

Box 7.2.f: Examples of organizations offering Table of Contents (TOC) services

- British Library Direct (free):
  - direct.bl.uk/bld/Home.do
- British Library Direct Plus (subscription):
  - www.bl.uk/reshelp/atyourdesk/docsupply/productsservices/bldplus/
- British Library Inside (to be replaced by British Library Direct Plus) (subscription):
  - www.bl.uk/inside
- Current Contents Connect (subscription):
  - scientific.thomson.com/products/ccc/
- Scientific Electronic Library Online (SciELO) – Brazil (free):
  - www.scielo.br/
- Zetoc (Z39.to Table of Contents) (free as specified below):

  Zetoc provides access to the British Library's Electronic Table of Contents. It is free of charge for members of the Joint Information Systems Committee (JISC)-sponsored higher and further education institutions in the UK and all of NHS Scotland and Northern Ireland:
  - zetoc.mimas.ac.uk/

7.2.2.6 Conference abstracts or proceedings

Although conference proceedings are not indexed in MEDLINE and a number of other major databases, they are indexed in the BIOSIS databases (http://www.biosis.org/). Over one-half of trials reported in conference abstracts never reach full publication, and those that are eventually published in full have been shown to be systematically different from those that are never published in full (Scherer 2007). Further research is needed to determine whether reports of diagnostic accuracy studies presented at conferences follow a similar pattern (Brazzelli 2006, Brazzelli 2008). Authors may wish to consider identifying possibly relevant studies reported in conference abstracts through specialist database sources and by handsearching or electronically searching abstracts that are made available in print form, on CD-ROM or on the internet. Many conference proceedings are published as journal supplements but these sections are not always indexed in databases even if the journals themselves are (Hopewell 2007a). Many conference abstracts are also published free of charge on the internet. Mediconf (www.mediconf.com/) is an annual online directory which lists contact details and websites of thousands of conferences worldwide in a wide range of subject areas. Specialist conference abstract sources are listed in Box 7.2.g.

Box 7.2.g: Examples of specialist conference abstract sources

- Biological Abstracts/RRM (Reports, Reviews, Meetings):
  - scientific.thomsonreuters.com/products/barrm/
- BMC Meeting Abstracts (free):
  - www.biomedcentral.com/meetings/
- British Library Inside (to be replaced by British Library Direct Plus):
  - www.bl.uk/inside
- British Library Direct Plus:
  - www.bl.uk/reshelp/atyourdesk/docsupply/productsservices/bldplus
- Conference Papers Index:
  - www.csa.com/factsheets/cpi-set-c.php
- German Medical Science Meetings (free):
  - www.dimdi.de/static/en/db/dbinfo/gm03.htm
- ISI Proceedings:
  - scientific.thomsonreuters.com/products/proceedings/
- Meeting Abstracts (free):
  - gateway.nlm.nih.gov/gw/Cmd.

7.2.2.7 Web searching

There is little empirical evidence as to the value of using general internet search engines such as Google to identify potential studies (Eysenbach 2001). Searching research funders' and test manufacturer's websites might prove useful. Further information on searching the internet for studies for systematic reviews is summarized in a checklist produced by the Information Service at the Centre for Reviews and Dissemination at the University of York, UK (Information Service, Centre for Reviews and Dissemination 2008). If internet searches are completed, we recommend that review authors print and file a copy or save locally an electronic copy of details of information about any possibly relevant study found on the internet, rather than simply 'book-marking' the site, in case the record of the study is removed

or altered at a later stage. Authors can also archive cited web pages through www.webcitation.org (Eysenbach 2005).

7.2.3 Unpublished and ongoing studies

Some completed studies are never published. If it could be assumed that the results of unpublished studies on test accuracy are comparable to the results of published studies on the same test, the failure to identify unpublished results would not be an important threat to the validity of a systematic review. In studies of therapeutic interventions an association between significant results and publication has been documented (Dickersin 1997; Dickersin 2005). Until further research in this area has been conducted for diagnostic test accuracy studies it may be important to locate unpublished studies and include them in a systematic review, when eligible, to minimize the potential risk of bias.

There is no easy way to obtain information about test evaluations that have been completed but never published. Colleagues can be an important source of information about unpublished studies and informal channels of communication can sometimes be the only means of identifying unpublished data. Authors of relevant studies or other experts in the field might know about completed but unpublished studies (Reveiz 2006). Conference reports on topics of interest might be a source of potential authors and experts. One approach could be to send a formal letter of request for information to the contact author of reports of included studies, together with a list of relevant articles and the inclusion criteria for the review, and ask whether they know of additional studies, published or unpublished, or ongoing that might be relevant. A similar request could be sent to test manufacturers.

A search of electronic databases using the names of these authors and other experts may also yield additional published studies.

If found, information about possible relevant ongoing studies should be included in the review in the 'Characteristics of ongoing studies table (see Chapter 4, Section 4.6.5). Awareness of the existence of a possibly relevant ongoing study might also affect decisions about when to update a specific review. Information on research projects in progress can be found in online registers of ongoing research maintained by professional associations or national governments (for example, the US Health Services Research Projects in Progress www.nlm.nih.gov/hsrproj/; the UK National Research Register, archived in September 2007 (portal.nihr.ac.uk/Pages/NRRArchive.aspx), and superseded by the UK Clinical Research Network Portfolio Database portal.nihr.ac.uk/Pages/Portfolio.aspx, etc). No single, central register of ongoing diagnostic test evaluations currently exists.

7.2.4 Summary points

- We recommend that Cochrane review authors seek advice from their Trials Search Co-ordinator on sources to search;
- MEDLINE, EMBASE and the Cochrane Register of Diagnostic Test Accuracy Studies (when publicly available) are key sources to search for studies for inclusion in Cochrane systematic reviews of diagnostic test accuracy;
- Other national, regional, and subject-specific databases may be appropriate for searching according to the topic of the review;
- Other specialized databases for grey literature such as conference proceedings and dissertations, may be appropriate for searching, as publication types other than journal articles are often not indexed in the major bibliographic databases;
- We recommend that reference lists in related reviews, guidelines, included studies and other related articles be checked for additional studies;
- Citation searches of included studies and the use of the 'related articles' feature in databases such as PubMed may yield additional relevant studies;
- Handsearching journals and conference proceedings may yield additional relevant studies;

- Cochrane review authors may wish to consider trying to identify unpublished studies through colleagues and other experts who have published on the topic of the review;
- Cochrane review authors may wish to consider trying to identify ongoing studies through research registers, for example, and track these studies for possible inclusion in reviews on completion.

7.3 Planning the search process

7.3.1 Collaboration-wide search support initiatives

7.3.1.1 Involving Trials Search Co-ordinators and healthcare librarians in the search process

Most Cochrane Review Groups offer support to authors in study identification from the early planning stage to the final write-up of the review for publication in the *Cochrane Database of Systematic Reviews (CDSR)*. The range of services offered varies across CRGs according to resources available and most CRGs employ a Trials Search Co-ordinator to fulfil this role (see Section 7.1.1.1). Review authors are, therefore, encouraged to contact the TSC of their CRG at the earliest stage of their plans to undertake a Cochrane review of diagnostic test accuracy for advice and support on study identification. This is likely to cover which databases and other sources to search, and support in developing and running the range of search strategies required (in particular in databases not available to the review author at their institution), which are designed to maximize sensitivity (i.e. reduce the risk of missing relevant studies).

If authors are conducting their own searches, they should also bear in mind that the search process needs to be documented throughout in enough detail to ensure that it can be reported fully in the review, such that all the searches of all the databases are reproducible. The full search strategies for each database should be included in an appendix to the review (see Section 7.6.2.2). Review authors should, therefore, save all search strategies and take notes of the dates the searches were run and the number of records retrieved for each database to enable them to report the search process accurately when they come to write up this section of the review (see Section 7.6).

If the CRG is currently without a TSC, it is recommended that review authors seek guidance from a healthcare librarian or information specialist, where possible one with experience of supporting systematic reviews.

7.3.1.2 Diagnostic Test Accuracy Regional Support Units

Since 2003, The Cochrane Collaboration has been working to develop the review methods, author guidance and software that are required to publish Cochrane systematic reviews of diagnostic test accuracy. A clear need has been identified for the development and delivery of training across the Collaboration, and provision of additional methodological and administrative support to Cochrane Review Groups in the early stages to provide the specialist knowledge required to complete these reviews. Regional support units are being set up to meet these needs. The units will work with the Cochrane Review Groups within their region to assist them in the process of preparing and publishing Cochrane systematic reviews of diagnostic test accuracy. The units will also be involved in developing and delivering training programmes and assisting review groups to support authors with question formulation, searching for studies, methodological and statistical issues, software support, methodological peer review and in the publication process.

There are currently two regional support units funded to assist Cochrane Review Groups to support review authors wishing to register and publish Cochrane systematic reviews of diagnostic test accuracy: the Continental Europe Regional Support Unit (CESU), convened in February 2007, and the UK Regional Support Unit (UKSU), convened in September 2007. They offer a regular programme of training courses on performing reviews of diagnostic

accuracy studies for Cochrane Review Group editorial teams, Cochrane Centre staff and review authors within their regions. These include training on how to formulate a review question and how to develop a search strategy to reflect the key concepts in the review question. The Australasian Regional Support Unit and the American Regional Support Unit have not yet been convened.

Details of training events, the latest version of the Cochrane Handbook for Systematic Reviews of Diagnostic Test Accuracy, and other resources are available from the regional support units' website.

Contact details for the regional support units are:

CESU – cesu@amc.uva.nl
UKSU – uksu@contacts.bham.ac.uk

website – http://srdta.cochrane.org/

7.3.1.3 Cochrane Register of Diagnostic Test Accuracy Studies

Introduction

The overall aim is to develop a clean and comprehensive study-based register of reports of diagnostic test accuracy studies that will provide:

- support for Cochrane Review Groups to develop Cochrane reviews of diagnostic test accuracy;
- a mechanism to re-tag diagnostic test accuracy studies with a searchable field name in electronic databases (e.g. diagnostic accuracy as a Publication Type or subject heading);
- a resource for methodological research of diagnostic test accuracy studies.

The need for a register of diagnostic test accuracy studies (DTAS) was identified by the Cochrane Diagnostic Reviews of Test Accuracy Working Group in 2004. A proposed model for the register was developed, and then circulated to Collaboration entities in May 2005 for comment. A funding proposal for the Register was included with the funding proposal for Diagnostic Test Accuracy Regional Support Units presented to The Cochrane Collaboration Steering Group (CCSG) at its April 2006 meeting. The CCSG approved two-year funding for the Register, which is being developed and maintained at the editorial base of the Cochrane Renal Group in Sydney, Australia.

This centrally managed model was adopted as a more sustainable option in terms of cost and quality control than the model that currently exists for the Cochrane Central Register of Controlled Trials (CENTRAL) in *The Cochrane Library*. The 50 Cochrane Review Groups (CRGs) currently develop and maintain separate CRG-specific specialized registers of randomized controlled trials, which are then combined to form CENTRAL. It was felt that they would not have the resources to maintain similar registers of DTAS, especially considering that searching for and identifying such studies is more difficult and time-consuming than for randomized controlled trials (Bossuyt 2003b; Doust 2005; Mitchell 2005; Leeflang 2006; Ritchie 2007).

An initial plan has been developed for the Register. It can be viewed at:

- www.cochrane.org/docs/DiagnosticTestRegisterPlan.doc.

In addition, a small reference group with expertise in search strategy development and diagnostic reviews has been formed to provide Register staff with advice and practical assistance in developing search protocols for building the register. Current members as at June 2008 are: Julie Glanville (Cochrane Information Retrieval Methods Group), Mariska

Leeflang (Continental Europe Regional Support Unit, The Netherlands), Marie Westwood (Centre for Reviews and Dissemination, University of York, UK) and Anne Eisinga (UK Regional Support Unit, University of Birmingham, UK).

Register Development
The Register will be built in an iterative fashion through several strategies:

- studies from existing non-Cochrane reviews sourced from DARE, MEDLINE and the MEDION databases;
- studies from Cochrane reviews;
- studies from the Renal Group's database of renal-related DTAS;
- studies identified through MEDLINE searches using methodological terms. This is at a pilot stage of testing strategies and developing screening protocols.

The Register is currently held in a Reference Manager database using a specially designed workform. As well as fields for the usual bibliographic information, it also has fields for information about index tests, reference standards, target conditions, population and setting, and a field for study name. Studies included in existing reviews also have the review details entered into a field called 'Related Systematic Review'.

References to studies found by any of the strategies above are downloaded into Reference Manager from MEDLINE whenever possible, or hand-entered. Subject headings (MeSH terms) are kept in the Keywords field, and information regarding index tests, reference standards, etc., are entered in the relevant fields. An Excel database of names used to describe index tests and reference standards is being built, since discussion concerning the standardization of these names will be needed within the wider Cochrane diagnostic test review community. There are often no specific MeSH terms, especially for newer tests.

Cochrane review authors can contribute the included studies from their review to the Register as well as excluded studies, which did not meet the review's inclusion criteria, but which are deemed to be diagnostic test accuracy studies.

Future development
A relational database structure is required for the register to realise its potential for being study-based (i.e. individual references about the same study are attached to one study name), and for it to incorporate such useful capabilities as field pick lists, reference-tracking linked to Cochrane review author names and review titles, and prospective assignment of new references to existing Cochrane reviews for updating. It is intended to use the Collaboration's existing MeerKat Access-based software to explore how this might work.

The Register is not yet publicly available. It will take some time until the Register can become the diagnostic test study equivalent of the CENTRAL database. Until then, anyone interested in more details about the Register are welcome to contact Ruth Mitchell, Trials Search Co-ordinator for the Cochrane Renal Group, who is managing the project, at ruthm4@chw.edu.au. Review authors from the Australasian region are also welcome to contact her for advice concerning search strategy development. Review authors from other regions should contact their Cochrane Review Group (see Section 7.3.1.1) and check for training opportunities offered by their regional support unit (see Section 7.3.1.2).

7.3.2 Summary points

- Cochrane review authors can seek advice from their Trials Search Co-ordinator throughout the search process;
- The full search strategies for each database searched need to be included in an appendix to the review, so all search strategies should be saved and notes taken of the dates the searches were run and the number of records retrieved for each database searched;

- Authors are encouraged to attend training sessions offered on a regular basis by their regional support units, which include sessions on the formulation of the review question and guidance on searching for studies;
- A Cochrane Register of Diagnostic Test Accuracy Studies is being developed to which the included studies of authors' reviews can be contributed. Excluded studies which did not meet the review's inclusion criteria, but which are deemed to be diagnostic accuracy studies, can also be contributed;
- When publicly available, the Cochrane Register of Diagnostic Test Accuracy Studies should be searched for all Cochrane reviews of diagnostic test accuracy.

7.4 Designing search strategies

7.4.1 Designing search strategies – an introduction

This section highlights some of the issues to consider when designing search strategies, but to address the many complexities in this area and adapt them to suit the purposes of a particular review, authors are highly recommended to consult their Trials Search Co-ordinator or local healthcare librarian.

Many of the issues highlighted below relate to the key challenges facing Cochrane review authors of diagnostic accuracy studies: (i) incomplete reporting by authors of diagnostic accuracy studies and (ii) the lack of availability of appropriate subject headings, and inconsistent use of those which are available, by database indexers. This has meant that the methodological aspect of the search (such as applying a set of terms or 'search filter' to denote diagnostic accuracy) is problematic which leaves the subject of the search (such as terms denoting the index test(s), target condition of interest and patient population) unable to be further refined without the risk of missing potentially relevant studies. Until widespread uptake of the STARD initiative to improve reporting of diagnostic accuracy studies (Bossuyt 2003a; Bossuyt 2003b) has been achieved, and sufficient subject headings introduced and applied consistently by database indexers, searches designed to be sensitive (i.e. to reduce the risk of missing relevant studies) are likely to result in low precision (i.e. high numbers of irrelevant records).

The eligibility criteria for studies to be included in the review (see Chapters 4 and 6) specify the types of studies, participants, index test(s), comparator test(s) if applicable, target condition(s) being diagnosed, and reference standards. Some criteria have been found to be more suitable for searching than others and these will be addressed in this section. Issues to consider in planning a search include the following:

- the nature of the index test(s) being evaluated and in particular the range of terminology likely to be used to denote them;
- whether a comparator test is being evaluated and the range of terminology likely to be used to denote it;
- the nature of the target condition being detected and in particular the range of terminology likely to be used to denote it;
- the nature of the patient population under study and in particular the range of terminology likely to be used to describe it;
- the reference standard(s) being used against which the accuracy of the index test(s) are to be measured and in particular the range of terminology likely to be used to describe it;
- the time period when any evaluations of the index test(s) may have taken place;
- any geographic considerations such as the need to include a search of a specific region's literature where the target condition is prevalent and the index test(s) are likely to have been studied in a more severely diseased population, if this would reflect the research question more closely;
- whether data from unpublished studies are to be included.

7.4.2 Structure of a search strategy

The structure of a search strategy should be based on the key concepts examined in the review. For a Cochrane review of diagnostic test accuracy, the review title should provide these key concepts: the diagnostic test(s) of interest (index test), the clinical condition of interest (target condition), and a defined study population (patient description) (see Chapter 4 Section 4.2.1 and Chapter 6).

It is usually unnecessary, and even undesirable, particularly for reviews of diagnostic accuracy, to search on every component of the review as outlined in the eligibility criteria for studies to be included in the review. Although the research question may address particular populations, clinical settings and use particular reference standards, these concepts may not be well described in the title or abstract of an article and are often not well indexed with subject headings. They are, therefore, generally less useful for searching, and, if used to refine the search further, may result in missed studies (van der Weijden 1997; Fielding 2002; Vincent 2003).

Currently, a search strategy to identify studies for a Cochrane review of diagnostic test accuracy will typically have two sets of terms: (i) terms to identify the index test(s) under evaluation; (ii) terms to search for the target condition(s) to be detected.

Index test(s)

In some cases the test of interest is very specific in its name and use: for example, the dipstick detecting nitrite and leucocytes in urine is uniquely aimed at diagnosing urinary tract infections; and mammography is uniquely performed to detect breast cancer. However, in many cases there are multiple names for the test, for example FDG PET (Mijnhout 2000; Mijnhout 2004), or the review may cover a class of tests (laboratory tests to diagnose liver pathology, for example), or physical examination, or patient history. It is important that a wide range of terms are used (text words and subject headings, where available) to ensure that the many different ways in which a test is described may be captured by the search.

Target condition

The target condition is a particular disease or disease stage that the index test is intended to detect.

At present, we do not recommend the routine use of a third set of terms or 'methodological search filter' to identify diagnostic accuracy studies as currently even the most sensitive filters have been found to miss relevant studies and perform inconsistently across subject areas and study designs while at the same time not significantly reducing the number of studies that have to be assessed for inclusion (see Section 7.4.11).

It is advisable to run a series of preliminary searches using a range of search terms (see Section 7.4.5) with the aim of identifying useful text words and database subject headings for the final search strategy for the review. During these preliminary searches, it is also important to note which key concepts are being described by the authors and database indexers so that the structure of the search strategy can be designed to maximize retrieval of relevant studies. For example, if the reference standard is being routinely described (and this is not always the case) then it may well be worth including this concept in the structure of the search, particularly if the index test is described poorly, or with such a wide range of terms that there is a risk of missing including some of these. The structure of the search strategy could then be adapted from the basic combination of the two concepts: index test(s) AND target condition, to a combination with potentially greater sensitivity in this particular context: (index test(s) OR reference standard) AND target condition. We recommend that authors seek advice from the Trials Search Co-ordinator of their CRG or their local healthcare librarian on how to adapt

the structure of the search strategy to minimize missing relevant studies. For more information on combining concepts as search sets see Section 7.4.7.

7.4.3 Service providers and search interfaces

Both MEDLINE and EMBASE are offered by a number of service providers, with a range of search interfaces; for example Dialog offers both Dialog and DataStar. In addition, the US National Library of Medicine and Elsevier both offer access to their own versions of MEDLINE and EMBASE respectively; MEDLINE through PubMed, which is available free of charge on the internet, and EMBASE through EMBASE.com, which is available on subscription. Search syntax varies across interfaces and searches will need to be adapted accordingly. Many service providers offer links to full-text versions of articles on other publishers' websites, such as the PubMed 'Links / Link Out' feature.

7.4.4 Sensitivity versus precision

Searches for systematic reviews aim to be as extensive as possible in order to ensure that as many as possible of relevant studies are included in the review. It is, however, necessary to strike a balance between striving for comprehensiveness and maintaining relevance when developing a search strategy. Increasing the comprehensiveness (or sensitivity) of a search will reduce its precision and will retrieve more non-relevant articles.

Sensitivity is defined as the number of relevant records identified by a search strategy divided by the total number of relevant records on a given topic. It is a measure of the comprehensiveness of the search method. Highly sensitive strategies tend to have low levels of precision and vice versa.

Precision is defined as the number of relevant records identified by a search strategy divided by the total number of records identified. It is a measure of the ability of a search to exclude irrelevant articles.

In searches for diagnostic studies to be included in Cochrane reviews emphasis is placed on high sensitivity to try to reduce the risk of missing relevant studies. Achieving an appropriate balance between sensitivity and precision is particularly challenging in diagnostic accuracy reviews. Incomplete reporting by authors of index test(s), target condition(s), diagnostic accuracy measures, reference standards and study populations in primary studies (Lijmer 1999) and reviews of diagnostic test accuracy (Mallett 2006), together with inconsistent indexing and a lack of availability of subject headings, and abstracts in databases (Doust 2005; Mitchell 2005) makes improving the precision of a search, without sacrificing sensitivity, challenging. Depending on the topic and search strategy used in MEDLINE, sensitivity of more than 90% has been achieved (van der Weijden 1997; Haynes 2004; Vincent 2003; Franceschini 2006; Fraser 2006; Ritchie 2007, Astin 2008) but not consistently (for those assessed in recent performance evaluations, see Section 7.4.11) and often resulted in a precision of markedly less than 10%. Precision can also be interpreted as corresponding to the number of records needed to read (NNR) to find one relevant paper. The NNR is defined by the formula: [1 / precision] (Bachmann 2002). Depending on the topic under review, authors of Cochrane reviews of diagnostic test accuracy may retrieve thousands of records to scan for studies potentially relevant for their review.

7.4.5 Database subject headings and text words

MEDLINE and EMBASE (and many other databases) can be searched using standardized subject headings assigned by database indexers. Standardized subject headings (as part of a database thesaurus) are useful because they provide a way of retrieving articles that may use different words to describe the same concept and because they can provide information beyond that contained in the words of the title and abstract. They should be used in combination with text words as the consistency in which subject headings are assigned to

records can be hampered by authors not describing their methods or objectives with sufficient detail. In addition, the available subject headings might not correspond to terms the searcher wishes to use.

Subject headings for MEDLINE (MeSH) and EMBASE (EMTREE) are not identical, neither is the approach to indexing. EMBASE records are often indexed in greater depth than the equivalent MEDLINE record, and in recent years Elsevier has increased the number of subject headings assigned to each EMBASE record. Searches of EMBASE may, therefore, retrieve additional articles that were not retrieved by a MEDLINE search, even if the records were present in both databases. Search strategies need to be customized for each database searched.

Developing a search strategy for a particular database is an iterative process and it should prove fruitful to conduct a series of preliminary searches using a range of subject headings and text words to identify additional search terms from records of retrieved studies that seem potentially relevant. One way to begin to identify subject headings for a particular database is to retrieve some key articles (which may already be known to the review authors) from that database that meet the inclusion criteria for the review, and to note common text words and their variants (synonyms, abbreviations, spelling variants, common mis-spellings) as well as subject headings the database indexers have assigned to the articles, which can then be used to develop a full search strategy for the review covering the key concepts which best describe the research topic (see Box 7.4.a).

Once a key article has been identified, additional relevant articles can be located, for example by using the 'Find Similar' option in Ovid or the 'Related Articles' option in PubMed, and these additional relevant articles can be checked for useful search terms to add to the search strategy. Another source of potentially useful search terms to test out are those published in search strategies in related reviews (see Section 7.2.2.1). Additional subject headings can also be identified using the search tools provided with the database, such as the Permuted Index under Search Tools in Ovid and the MeSH Database option in PubMed. Studies only found in the reference sections of retrieved studies but missed by the search can also be searched for in the database, using the author names, terms from the title or other bibliographic data. If a study is found in the database, its subject headings and text words should be noted and any deemed potentially useful, can be incorporated in the search strategy, if appropriate. Adding additional search terms to the strategy (MeSH or text words) in this way may make the search less specific and can result in a large number of irrelevant references, and so further testing of terms may be needed at this stage to achieve an appropriate balance of sensitivity and precision. During these preliminary searches to identify useful text words and database subject headings, it is also important to note which key concepts are being described by the authors and database indexers so that the structure of the search strategy can be designed to maximize retrieval of relevant studies (see Section 7.4.2).

Many database thesauri offer the facility to 'explode' subject headings which have more specific terms associated with them. To capture these more specific terms, in databases that offer the facility, it is possible to 'explode' the highest level term and so search for several terms at once. For example, a MEDLINE search using the MeSH term 'Prenatal Diagnosis', if exploded will automatically search not only for the term 'Prenatal Diagnosis' but also for more specific types of prenatal diagnosis including the term 'Amniocentesis'. As articles in MEDLINE on the subject of amniocentesis should only be indexed with the more specific term 'Amniocentesis' and not also with the more general term 'Prenatal Diagnosis', it is important that MeSH terms are 'exploded' where appropriate, in order not to miss relevant articles. The same principle applies to subject headings (EMTREE terms) in EMBASE and a number of other databases.

Review authors should assume that earlier articles are even harder to identify than recent articles. For example, abstracts are not included in MEDLINE for most articles published before 1976 and, therefore, text word searches will only apply to titles for this period. In addition, few MEDLINE subject headings relating to study design and methodology were available before the 1990s, so text word searches are necessary to retrieve older records (Wilczynski 1995; Vincent 2003).

In order to identify as many relevant studies as possible, the search strategy should comprise a combination of subject headings, selected from the database thesaurus ('exploded' where appropriate), and a wide range of text words. This type of approach should then be carefully adapted for each database to be searched using the subject headings and syntax appropriate for each database (Falck-Ytter 2004).

Box 7.4.a: How to develop a search strategy (example).

Review title
Clinical assessment for diagnosing congenital heart disease in newborn infants with Down syndrome

Identify the key concepts in the review title (not all may be needed for searching)

Index test(s):	clinical assessment
Target condition:	congenital heart disease
Patient description:	newborn infants with Down syndrome

Identify synonyms, spelling variants, acronyms, abbreviations and subject headings to describe each key concept e.g. for clinical assessment the following may be useful:

Text words	**MEDLINE subject headings (MeSH)**
Auscultation	Physical Examination (explode)
Palpation	Electrocardiography
Electrocardiography	Oximetry
ECG	
Electrocardiogram	
Low oxygen saturation	
Pulse oximetry or pulse oximeter	
Clinical examination or clinical assessment	
Physical examination or physical assessment	
Observation	
Chest radiograph or chest roentgenogram or chest X-ray	

We recommend that authors seek advice and support from their Cochrane Review Group's Trials Search Co-ordinator or local healthcare librarian in developing and running search strategies for the review (see Section 7.3.1.1).

7.4.6 Synonyms, related terms, variant spellings, truncation and wildcards

When designing a search strategy, in order to be as comprehensive as possible, it is necessary to include a wide range of text words for each of the concepts selected to be searched. For example:

- Synonyms: 'newborn' or 'neonate', etc;
- Related terms: 'Down Syndrome' or 'trisomy 21';

- Variant spellings: ‘paediatric’ or ‘pediatric’.

Service providers offer facilities to capture these variations through truncation and wildcards:

- Truncation: electrocardiogra* (for electrocardiogram, electrocardiograph, electrocardiography, etc);
- Wildcard: wom?n (for woman or women)

These features vary across service providers. For further details check the service provider help files for the databases you wish to search.

7.4.7 Boolean operators (AND, OR and NOT)

Once a series of search terms (subject headings, text words, synonyms, related terms) for each ‘key concept’ has been compiled, the concepts are then combined to create a set of results which should contain relevant articles for the review (see Figure 7.4.a).

It is usually effective to use the Boolean ‘OR’ operator to combine terms relating to the same concept (all the search terms for the index test(s), for example) before narrowing down a search using the ‘AND’ operator with another set of search terms describing the second concept (target condition, for example).

It may be helpful to add a third set of search terms to describe the patient population, if this is particularly pertinent to the review and is likely to be described well in the title or abstract or subject headings (e.g. newborn infants with Down Syndrome). However, currently we do not recommend routine use of a third set of terms or ‘search filter’ to describe diagnostic accuracy, as methodological terms for this concept have been found to be inconsistently used as text words or subject headings. If an article does not contain at least one term from each of the three sets, it will not be identified and so authors may wish to omit a third set of terms if the numbers of records retrieved by the first two sets (for index test(s) and target condition) are not excessive.

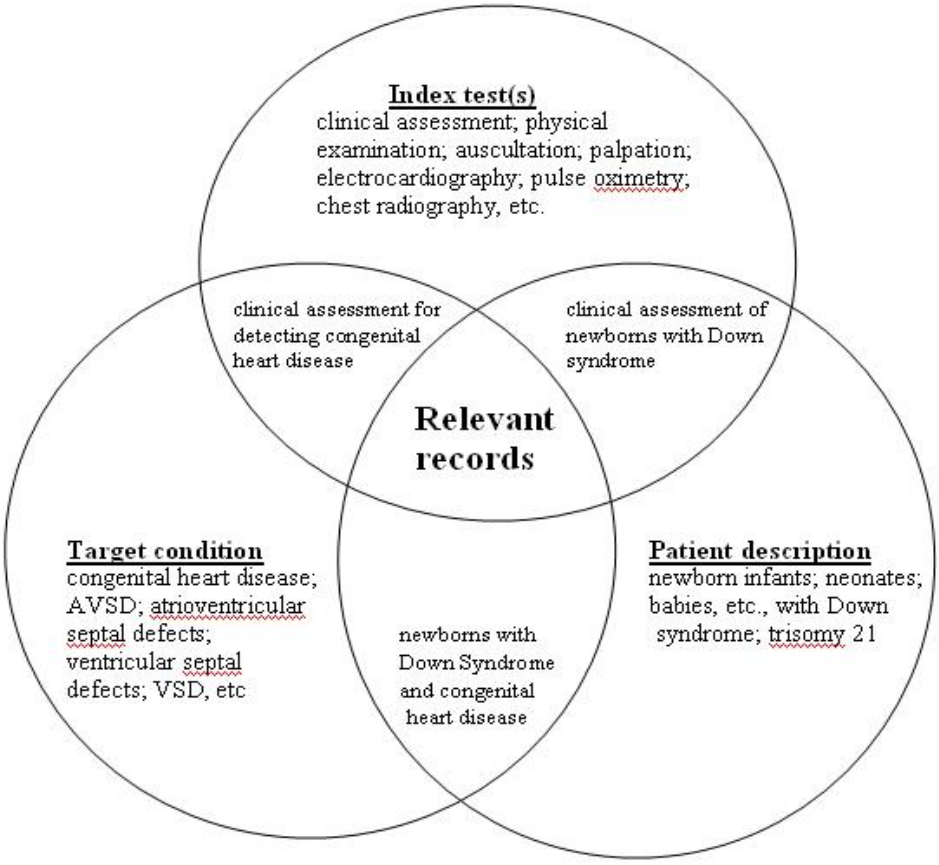
If the results of the search are too many to deal with pragmatically then there are options to reduce the yield further and assistance of the Cochrane Review Group’s Trials Search Co-ordinator or healthcare librarian is strongly recommended at this stage to try to minimize the loss of relevant studies. Authors might consider:

- refining the subject specific terms, for example, by selecting terms for subgroup(s) of the target condition if these are the particular focus of the review;
- refining the search to a particular time period but only if the diagnostic tests of interest are substantially improved over time and the review focuses on the most recent versions;
- adding a third set of terms to describe the patient population such as a particular age group (as in the example above: newborns with Down Syndrome) but making sure that a wide range of subject headings and text words are selected to cover this concept. However, although a research question may address particular populations, clinical settings and reference standards, these concepts are often not well described with text words in titles and abstracts (where available) or assigned subject headings consistently and, if used to restrict a search further, would generally result in missed studies (van der Weijden 1997; Fielding 2002; Vincent 2003);
- excluding case reports as a publication type (NOT case reports[PT]) but generally the ‘NOT’ operator should be avoided where possible to avert the danger of inadvertently removing from the search set records that are relevant. For example, when searching for

records coded as 'female', 'NOT male' would remove any record that was about males and females;

- restricting the results to studies involving humans;
- careful use of proximity operators such as NEAR, NEXT and ADJ (see Section 7.4.8). These can help to make the search more specific (by retrieving words next to or within a specified number of words of each other) and are particularly useful if the key concepts contain phrases as search terms;
- adding a third set of methodological terms or 'search filter' designed to retrieve studies of diagnostic accuracy. Filters have been developed in MEDLINE, including for use in PubMed, and EMBASE (Haynes 1994; van der Weijden 1997; Devillé 2000; Bachmann 2002; Devillé 2002b; Bachmann 2003; Vincent 2003; Haynes 2004; Berg 2005). Currently, we do not recommend this option as even the most sensitive filters have been found to miss relevant studies and perform inconsistently across subject areas and study designs, without significantly reducing the numbers of records to screen (see Section 7.4.11).

Figure 7.4.a: Combining concepts as search sets



7.4.8 Proximity operators (NEAR, NEXT and ADJ)

In some search interfaces it is possible to specify, for example using the 'next' operator, that two search terms should be adjacent to each other, rather than simply allowing the search to default to finding both words in the document as if the 'AND' operator had been used. Quotation marks can also often be used to specify an exact phrase to be retrieved. A further refinement to specify that the search terms should be within a specified number of words of each other can be applied in some search interfaces. For example, 'adj5' or 'near5' indicates

that the search terms should be within five words of each other - this results in higher sensitivity than exact phrase searching (search terms next to each other) but greater precision than the use of the 'AND' operator (search terms in the same document).

7.4.9 Language, date and type of document restrictions

Further research is needed to determine whether positive results in diagnostic accuracy studies are at risk of language and other reporting biases. Whenever possible, we recommend that review authors attempt to identify and assess for eligibility all possibly relevant studies irrespective of language of publication. Ideally, no language restrictions should therefore be included in the search strategy.

Restricting the search to a particular time period can be considered but only if the diagnostic test of interest was introduced from a particular date or has been substantially improved over time and the review focuses only on the most recent versions.

Excluding types of document, such as letters for example, may not be advisable as this may result in missed additional information relating to an earlier study or new information about a study not reported elsewhere. Review authors undertaking systematic reviews of randomized controlled trials are advised against excluding all letters as those indexed with the Publication Type 'randomized controlled trial' have been found to present extractable outcome data as well as data on blinding of participants and investigators, harms, and have also reported negative results, which may be influential in reducing publication bias (Iansavichene 2008). Review authors of systematic reviews of interventions are therefore advised to use 'NOT (letter.pt. NOT randomized controlled trial.pt.)' if they wish to exclude letters from a MEDLINE search. Further research is needed to determine whether important diagnostic accuracy data, likely to influence summary estimates of accuracy, are published in letters. Also, until a specific publication type or subject heading for diagnostic accuracy studies is introduced and assigned consistently to database records, authors undertaking systematic reviews of diagnostic test accuracy will not be able to adapt the method given above to retrieve potentially relevant letters and exclude non-relevant letters. Whenever possible, we suggest that authors attempt to identify all possibly relevant studies irrespective of document type.

7.4.10 Identifying fraudulent studies, other retracted publications, errata and comments

When considering eligibility of studies for inclusion in a Cochrane review, it is important to be aware that some studies may have been retracted since publication because they have been found to be fraudulent, or for a variety of other reasons (Sox 2006). Reports of retracted studies in MEDLINE are assigned the term 'Retracted Publication' as a Publication Type. The article announcing the retraction will have the Publication Type 'Retraction of Publication' assigned to it. Before any decision being taken to retract a study, articles may be published that refer to an original study and raise concerns of this nature. These articles would be classified as a Comment. The US National Library of Medicine's policy on this is that "Among the types of articles that will be considered comments are: …announcements or notices that report questionable science or investigations of scientific misconduct (sometimes published as 'Expression of concern')":

- www.nlm.nih.gov/pubs/factsheets/errata.html

In addition, articles may have been partially retracted, corrected through a published erratum or may have been corrected and re-published in full. When updating a review, it is important to search MEDLINE for the latest version of the citations for the included studies. In some versions of MEDLINE the retracted publication, erratum, and comment statements are included in the citation data immediately after the title. This is not always the case and so

authors should take care that this information is retrieved by downloading the appropriate fields together with the citation data (see Section 7.5.2).

7.4.11 Search filters

The routine use of methodology filters for searching for diagnostic accuracy studies for Cochrane systematic reviews is not currently recommended because even the most sensitive filters have been found to miss relevant studies and perform inconsistently across subject areas and study designs (Doust 2005; Mitchell 2005; Leeflang 2006; Ritchie 2007, Glanville 2008b) while at the same time not significantly reducing the number of studies that have to be assessed for inclusion (Leeflang 2006; Ritchie 2007, Whiting 2008b).

The accuracy of a diagnostic test can be expressed using a range of terms: sensitivity and specificity, positive and negative predictive values, positive and negative diagnostic likelihood ratios, diagnostic odds ratios, and summary receiver operating characteristics (SROC). Variation in the reporting of measures of diagnostic test accuracy has implications for the development of an appropriate methodological search filter in that a matching range of database subject headings (where available) combined with text words likely to be used by the author in the title and abstract (where available) need to be identified.

Honest and Khan (2002) assessed the measures of accuracy used for reporting results of primary studies as well as meta-analyses of such studies in 90 systematic reviews of diagnostic test accuracy identified from the Database of Abstracts of Reviews of Effects (DARE) (1994 to 2000), 60 of which used meta-analysis. Sensitivity or specificity was used for reporting the results of primary studies in 65/90 (72%) of reviews, predictive values in 26/90 (28%), and likelihood ratios in 20/90 (22%). Summary ROC was used in 44/60 (73%) of the meta-analyses. There were no significant differences in measures of test accuracy among reviews published earlier (1994-1997) and those published later (1998-2000).

Not all databases have subject headings for measures of accuracy and those that do are not always applied consistently or have only been introduced in recent years. Strategies in MEDLINE are likely to have much lower precision in studies published before 1991 due to non use of methodological MeSH terms (Wilczynski 1995). The MeSH term ‘Sensitivity and Specificity’, for example, was not introduced until 1991. Authors also do not consistently report measures of accuracy in the title or abstract, and older studies are less likely to contain abstracts, which reduces the efficiency of text word searching. These deficiencies in database indexing and text word searching have been found to compromise the effectiveness and efficiency in performance of existing methodological search filters for diagnostic test accuracy studies, leading to the omission of relevant studies (Vincent 2003; Doust 2005; Mitchell 2005; Leeflang 2006; Ritchie 2007, Glanville 2008b).

Ritchie and colleagues (2007) assessed the performance of 23 published and unpublished methodological search filters (Haynes 1994; Devillé 2000; Bachmann 2002; Devillé 2002b; Shipley 2002; Vincent 2003; Falck-Ytter 2004; Haynes 2004; Critical Appraisal Skills Programme 2006; InterTASC Information Specialists’ Subgroup 2006) in finding 160 studies in MEDLINE included in one diagnostic review of urinary tract infections. The original review had used sensitive searches across multiple databases to locate studies and had not applied a diagnostic search filter. The sensitivity of the strategies ranged from 20.6% to 86.9%, precision ranged from 1% to 9.4%. The strategy designed by Vincent and colleagues (2003) performed best in terms of the best compromise of sensitivity (86.9%) and precision (3.3%). No strategies had adequate sensitivity for systematic review searching.

Leeflang and colleagues (2006) assessed the performance of 12 search filters (Haynes 1994; van der Weijden 1997; Devillé 2000; Bachmann 2002; Devillé 2002a; Devillé 2002b; Vincent 2003; Haynes 2004) to find included studies (range 10 to 110) from 27 reviews in MEDLINE

with a variety of index tests and target conditions covering laboratory diagnosis (7), physical examination (5), diagnostic imaging (15) and history taking (1). The included studies had been identified from a range of sources without the use of a diagnostic search filter. The sensitivity of the strategies just using the diagnostic filter ranged from 8% to 100%. The mean sensitivity of filters designed to be sensitive was 86%. The number needed to read (NNR), a proxy for precision (Bachmann 2002), was calculated on six reviews, where the search strategies were reported in sufficient detail to be reproduced, and ranged from 13 to 275.3. The search filters with the largest decrease in NNR also had the highest number of missed studies. The search filters performed less well on older records. The strategy designed by van der Weijden and colleagues (1997) performed best in terms of sensitivity (mean 98%) but Leeflang and colleagues (2006) currently recommend against the use of search filters because of the wide range of study designs for diagnostic test accuracy studies and the poor indexing of these in MEDLINE. The poor reporting of the search strategies used in the reviews meant that Leeflang and colleagues (2006) were unable to determine the adequacy of the literature searches for the reviews and whether relevant studies had been missed. In an earlier study, for example, Vincent and colleagues (2003) had found an additional 147 studies not cited in any of the 16 systematic reviews of diagnostic test accuracy studies used to produce the reference set of studies to evaluate their search filters.

Doust and colleagues (2005) assessed the performance of five search filters (Haynes 1994; van der Weijden 1997; Devillé 2000; Bachmann, 2002; Devillé 2002b) to find included studies in MEDLINE from two reviews which had identified studies in PubMed using a diagnostic search filter and reference checking. The sensitivity of the search filters ranged from 73% to 91% for one review (33 included studies) with precision from 3% to 9%. For the other review (20 included studies) sensitivity ranged from 90% to 100% with precision from 1% to 9%. The subject search alone performed better than the filters in terms of sensitivity. Using a filter improved precision but for one review reduced sensitivity. The authors recommended the use of the strategy designed by van der Weijden and colleagues (1997) as having the greatest sensitivity without significant loss of precision. However, the original searches for the reviews had identified studies from only one database and had used a diagnostic filter and it may be that relevant studies will have been missed.

Mitchell and colleagues (2005) assessed the performance of nine search filters (Haynes 1994; van der Weidjen 1997; Devillé 2000; Bachmann 2002; Vincent 2003;Haynes 2004) in MEDLINE to find 100 studies of diagnostic test accuracy identified by handsearching three kidney journals for 1990 to 1991 and 2002 to 2003. Four of the search filters were adapted for EMBASE. In MEDLINE sensitivities ranged from 37% to 83% and precision from 5% to 23%. In EMBASE sensitivities ranged from 43% to 84% and precision from 8.5% to 24.5%. None of the filters performed with adequate sensitivity for systematic review searching. The primary reason for missed studies was inadequate indexing of methodological terms.

Vincent and colleagues (2003) designed a search filter to identify diagnostic test accuracy studies based on five existing filters (Haynes 1994; Devillé 2000, Diagnostic Procedures 2002; McKibbon 2002; Shipley 2002). They assessed the performance of three versions of their filter in comparison to the original five existing filters in MEDLINE to identify a reference set of 126 studies, published from 1969 to 2000, limited to the English language, and cited by 16 systematic reviews on diagnostic tests for deep vein thrombosis. Sensitivities ranged from 53.2% to 100% and precision from 2.5% to 10.8%. The final strategy by Vincent and colleagues (2003) achieved 98.4% sensitivity and also identified 147 additional relevant studies not cited by the 16 systematic reviews, which increased its precision to 8.8%. However, the Vincent filter performed with reduced sensitivity in recent performance evaluations (Leeflang 2006; Ritchie 2007; Glanville 2008b).

Research into the development and performance assessment of methodological filters for retrieving diagnostic test accuracy studies is a fast-moving area (Alldred 2006; Franceschini

2006; Fraser 2006; Leeflang 2007, Astin 2008) and the potential to develop new, more effective filters remains. Whiting and colleagues (2008a) intend to undertake textual analysis of the gold standard sets from their recent study of sources of diagnostic test accuracy studies, using the methods they and others developed (White 2001), which were recently used to revise the Cochrane Highly Sensitive Search Strategy for identifying reports of randomized trials in MEDLINE (Lefebvre 2008). A key area for research is to compare the proportion of a consistently derived gold standard set of studies identified by searches that used a diagnostic filter with the proportion of studies identified by searches that did not use such a filter in order to address the important question of whether a filter reduces the number of relevant studies identified or simply limits the number of irrelevant titles and abstracts to be screened (Whiting 2008b). Research is also needed to assess whether the relevant studies missed by the search are significantly different from those included in the review in such a way that might affect the estimate of test accuracy. Such planned and ongoing research should produce further evidence for consideration on which to base search practice decisions.

A useful resource to monitor for methodological search filters (validated as well as pragmatic) for a variety of study designs, including diagnostic studies, is the Search Filter resource compiled and updated regularly by the UK InterTASC Information Specialists' Subgroup (ISSG). In addition, a search filter critical appraisal tool has recently been developed by this group (Glanville 2008a) and completed examples of critical appraisals of some filters have been added to the website:

- www.york.ac.uk/inst/crd/intertasc/diag.htm - search filters for diagnostic studies.
- www.york.ac.uk/inst/crd/intertasc/surveys.htm - studies on performance of search filters.

It is also hoped that the Standards for Reporting of Diagnostic Accuracy (STARD) initiative, (Bossuyt 2003a; Bossuyt 2003b) and its applications (Simel 2008) will continue to improve the accuracy and completeness of reporting research methods by authors and journal editors in studies describing diagnostic test accuracy (Smidt 2006). Further uptake of this guidance, together with the introduction of specific subject headings (e.g. Publication Types) for diagnostic test accuracy studies in databases such as MEDLINE, which are not yet available, should make searching more efficient in future.

7.4.12 Updating searches

When a Cochrane review is updated, the search process (which databases and other sources to search for which years, and any refinements needed to the original search strategies) will need to be reviewed. Databases that were previously searched and are considered relevant for the update will need to be searched again from the date of the last search in that database to capture any studies added to it since that date (Barrowman 2003). Previous search strategies may need to be amended to address issues such as: changes in database indexing terms, for example, the addition or removal of subject headings (MeSH, EMTREE etc); changes in database search syntax; and comments or criticisms of the previous search strategies. If any of the databases originally searched are not to be searched for the update, this should be explained and justified. New databases or other sources may have been produced or become available to the authors or Trials Search Co-ordinator and these should also be considered.

Deciding whether, and when, to update a review is problematic, as there is limited empirical evidence to suggest the ideal time for updating to accommodate newly identified information (Moher 2007a). In practice, reviews in rapidly moving fields may need to be updated more often than other reviews, where the evidence is relatively stable. Monitoring the literature for a review helps authors to gauge whether research in an area is moving at a fast or slow pace, potentially reflecting the need to update a review more or less frequently. Authors may wish

to consider the following surveillance methods for continual monitoring of the literature to identify whether new studies have been published that may signal the need to update the review:

- 'Auto alerts' via databases – making use of the automatic re-run of the original search strategy by the database service provider each time new studies are added to the database since the last search (e.g. in PubMed using the 'My NCBI' service; in Ovid using the 'Saved Searches Auto Alerts' service). Search results are sent automatically by e-mail or RSS feed. If desired, this service should be set up for each database, which offers this facility, at the time when the search strategy for the review is first implemented. If the original search strategy is amended at any time, for example necessitated by subsequent changes to subject headings made by database providers, a revised 'auto alert' will need to be set up;
- 'Citing alerts' via electronic journals – whenever a known relevant study in a particular journal is cited by others, these citing references are sent automatically by e-mail or RSS feed;
- PubMed 'related articles' feature – Sampson and colleagues (2008) found that using a subset of studies (e.g. three largest and three most recent) included in an original systematic review of interventions as 'seeds' to search for related articles in PubMed, restricted to material added to the database since the date of the last search and limited to study design (e.g. using the Clinical Queries option for clinically sound studies of therapies, optimized for sensitivity or specificity depending on the number of retrieved records), was an effective method to capture emerging evidence likely to signal the need to update a systematic review of interventions. Further research is needed to test whether adapting this surveillance method for reviews of diagnostic test accuracy would be similarly effective.
- 'Citation searches' – using Scopus or Science Citation Index, for example, to search for new studies that cite the original Cochrane review, restricted to material added to the database since the date of the last search.

7.4.13 Demonstration search strategies

The following demonstration search strategies are for the topic 'Clinical assessment for diagnosing congenital heart disease in newborn infants with Down syndrome' and are for illustrative purposes only: searches for studies to include in a systematic review would have more search terms for each of the concepts.

Box 7.4.b provides a demonstration search strategy for PubMed (MEDLINE). Box 7.4.c provides a demonstration search strategy for MEDLINE (Ovid format). Box 7.4.d provides a demonstration search strategy for EMBASE (Ovid format).

Box 7.4.b: Demonstration search strategy for PubMed (MEDLINE), for the topic 'Clinical assessment for diagnosing congenital heart disease in newborn infants with Down Syndrome'

("Physical Examination"[MeSH Terms] OR "Electrocardiography"[MeSH Terms:noexp] OR "Oximetry"[MeSH Terms:noexp] OR auscultat*[tw] OR palpat*[tw] OR electrocardiogra*[tw] OR ECG[tw] OR pulse[tw] OR oximet*[tw] OR (chest[tw] AND (radiogra*[tw] OR roentgenogra*[tw] OR x-ray*[tw] OR xray*[tw])) OR (thora*[tw] AND (radiogra*[tw] OR roentgenogra*[tw] OR x-ray*[tw] OR xray*[tw])) OR (physical*[tw] AND (examin*[tw] OR assess*[tw] OR sign[tw] OR signs[tw])) OR (clinical*[tw] AND (examin*[tw] OR assess*[tw] OR sign[tw] OR signs[tw]))) **AND**	Index test(s) set
("Heart Defects, Congenital"[MeSH Terms] OR (congenital*[tw]	Target condition set

AND (cardia*[tw] OR cardiol*[tw] OR cardiovasc*[tw])) OR (congenital*[tw] AND heart[tw]) OR (septal[tw] AND defect*[tw]) OR (septum[tw] AND defect*[tw]) OR AVSD[tw] OR VSD[tw] OR "patent ductus arteriosus"[tw] OR "Eisenmenger syndrome"[tw] OR "Eisenmengers syndrome"[tw] OR "Eisenmenger's syndrome"[tw] OR (tetralogy[tw] AND fallot[tw])) **AND**	
("Infant, Newborn"[MeSH Terms] OR neonate*[tw] OR newborn*[tw] OR baby[tw] OR babies[tw]) **AND** ("Down Syndrome"[MeSH Terms] OR "Down syndrome"[tw] OR "Downs syndrome"[tw] OR "Down's syndrome"[tw] OR "trisomy 21"[tw])	Patient description set

[MeSH Terms]	restricts the search to Medical Subject Headings and automatically 'explodes' the term to include all the more specific terms associated with it.
[MeSH Terms:noexp]	restricts the search to Medical Subject Headings but does not 'explode' the term.
[tw]	searches text words across the record included in the title, abstract, MeSH, Publication Types or Substance Names.
*	is the truncation symbol used to retrieve variant endings

Box 7.4.c: Demonstration search strategy for MEDLINE (Ovid format), for the topic 'Clinical assessment for diagnosing congenital heart disease in newborn infants with Down Syndrome'

1	exp Physical Examination/	Index test(s) set
2	Electrocardiography/	
3	Oximetry/	
4	auscultat$.mp.	
5	palpat$.mp.	
6	electrocardiogra$.mp.	
7	ECG.mp.	
8	pulse.mp.	
9	oximet$.mp.	
10	((chest or thora$) adj3 (radiogra$ or roentgenogra$ or x-ray$ or xray$)).mp.	
11	((physical$ or clinical$) adj3 (examin$ or assess$ or sign$)).mp.	
12	or/1-11	
13	exp Heart Defects, Congenital/	Target condition set
14	(congenital$ adj3 (cardi$ or heart)).mp.	
15	((septal or septum) adj defect$).mp	
16	AVSD.mp.	
17	VSD.mp.	
18	(patent adj ductus adj arteriosus).mp.	
19	(Eisenmenger$ adj syndrome).mp.	
20	(tetralogy adj2 fallot).mp.	
21	or/13-20	
22	exp Newborn, Infants/	Patient description set
23	(neonate$ or newborn$ or baby or babies).mp.	

24	or/22-23	
25	Down Syndrome/	
26	(Down$ adj syndrome).mp.	
27	trisomy 21.mp.	
28	or/25-27	
29	24 and 28	
30	12 and 21 and 29	Combined sets

exp search term/	restricts the search to Medical Subject Headings and automatically 'explodes' the term to include all the more specific terms associated with it.
search term/	restricts the search to Medical Subject Headings but does not 'explode' the term.
.mp.	indicates a search of the title, original title, abstract, words in the name of a substance or words in the subject headings.
$	is the truncation symbol used to retrieve variant endings.
adj3	restricts the search terms to be within 3 words of each other.
or/1-11	is the syntax used to combine search lines (1-11 in this example) with OR. Alternatively you can enter 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11.

Box 7.4.d: Demonstration search strategy for EMBASE (Ovid format), for the topic 'Clinical assessment for diagnosing congenital heart disease in newborn infants with Down Syndrome'

1	exp Physical Examination/	Index test(s) set
2	exp Auscultation/	
3	exp Electrocardiography/	
4	Pulse Oximetry/	
5	exp Thorax Radiography/	
6	auscultat$.mp.	
7	palpat$.mp.	
8	electrocardiogra$.mp.	
9	ECG.mp.	
10	pulse.mp.	
11	oximet$.mp.	
12	((chest or thora$) adj3 (radiogra$ or roentgenogra$ or x-ray$ or xray$)).mp.	
13	((physical$ or clinical$) adj3 (examin$ or assess$ or sign$)).mp.	
14	or/1-13	
15	exp Congenital Heart Malformation/	Target condition set
16	(congenital$ adj3 (cardi$ or heart$)).mp.	
17	((septal or septum) adj defect$).mp.	
18	AVSD.mp.	
19	VSD.mp.	
20	(patent adj ductus adj arteriosus).mp.	
21	(Eisenmenger$ adj syndrome).mp.	

22	(tetralogy adj2 fallot).mp.	
23	or/15-22	
24	Newborn/	Patient description set
25	Newborn period/	
26	(neonate$ or newborn$ or baby or babies).mp.	
27	or/24-26	
28	Down Syndrome/	
29	(Down$ adj syndrome).mp.	
30	(trisomy 21).mp	
31	or/28-30	
32	27 and 31	
33	14 and 23 and 32	Combined set

exp search term/	restricts the search to Medical Subject Headings and automatically 'explodes' the term to include all the more specific terms associated with it.
search term/	restricts the search to Medical Subject Headings but does not 'explode' the term.
.mp.	indicates a search of the title, original title, abstract, words in the name of a substance or words in the subject headings.
$	is the truncation symbol used to retrieve variant endings.
adj3	restricts the search terms to be within 3 words of each other.
or/1-13	is the syntax used to combine search lines (1-13 in this example) with OR. Alternatively you can enter 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13.

7.4.14 Summary points

- Before beginning the search process, we recommend that Cochrane review authors contact the Trials Search Co-ordinator of their Cochrane Review Group for advice and support in searching for studies for the review;
- Currently, a search strategy to identify studies for a Cochrane review of diagnostic test accuracy will typically have two sets of terms: (i) terms to search for the index test(s) under evaluation; (ii) terms to search for the target condition(s) to be detected;
- A third set of terms can be considered for (iii) patient description, if this is important to the review (e.g. clinical assessment for diagnosing congenital heart disease in newborn infants with Down Syndrome) and likely to be well described in the title / abstract and database subject headings;
- Routine use of a third set of terms as a methodology search filter to identify diagnostic test accuracy studies should be avoided as currently even the most sensitive filters have been found to miss relevant studies and perform inconsistently across subject areas and study designs while at the same time not significantly reducing the number of studies that have to be assessed for inclusion;
- Preliminary searches using a range of search terms can be helpful to identify useful text words and database subject headings for inclusion in the final search strategy for the review; other potentially useful sources of search terms are search strategies published in related reviews or guidelines, and making use of database search tools, such as thesauri;
- During preliminary searches to identify useful terms for the final search strategy for the review, it is also helpful to note which key concepts are described so that the structure of the search can be adapted to minimize the risk of missing relevant studies;

- A range of text words (synonyms, related terms) and database subject headings (e.g. MeSH, EMTREE) should be used to describe each key concept (e.g. index test(s), target condition), and tailored for each database to be searched;
- A range of search terms (text words and subject headings) will generally be combined with OR within each concept;
- Different search concepts will generally be combined with AND;
- Use of NOT in combining search sets should generally be avoided;
- High sensitivity should be aimed for which is likely to result in low precision;
- Using language restrictions should generally be avoided;
- If the search retrieves an unmanageable number of results, seek assistance from the Group's Trials Search Co-ordinator or local healthcare librarian for options to reduce the yield;
- Ensure awareness of relevant retracted publications, errata and comments relating to studies included in the review by downloading the appropriate fields containing this information from the databases searched;
- Cochrane review authors may wish to consider surveillance methods for continual monitoring of the literature (e.g. auto alert searches, citing alerts, 'related articles' searches, citation searches) to identify whether new studies have been published that may signal the need to update the review.

7.5 Managing references

7.5.1 Reference management software

Specially designed bibliographic or reference management software such as, EndNote (http://www.endnote.com/), ProCite (http://www.procite.com/), Reference Manager (http://www.refman.com/), and RefWorks (http://www.refworks.com/) is useful to keep track of the results of all the searches for the review. Many research departments and universities offer one of these systems free for use by staff members so it is worth checking local availability first before purchasing one. For a comparison of the above products and links to reviews of other bibliographic software packages see:

- www.burioni.it/forum/dellorso/bms-dasp/text/index.html.

Of the packages listed above, ProCite is generally considered to be very efficient for identifying duplicate references but is no longer updated by the suppliers and does not support the wider range of character sets allowing references to be entered correctly in languages other than English, whereas EndNote does. Reference management software also facilitates storage of information about the methods and process of retrieval of the search results. For example, separate unused fields can be used to store information such as 1) the name of the database or other source details from which a study was identified, 2) when and from where an article was ordered and the date of article receipt; and 3) whether the study retrieved is to be included in or excluded from the review and the reasons for exclusion.

Other options for managing references include general database packages such as Access and FoxPro which have powerful query capabilities and lend themselves well to customization, but require some programming and database design skills to set up. An Access-based software called 'MeerKat' (www.cochrane.co.uk/en/newPage1.html) has been developed by the UK Cochrane Centre, in association with Update Software, to address the specific needs of Cochrane Review Groups (CRGs) in managing their Specialized Registers of reports of randomized controlled trials. MeerKat will be investigated to develop the Cochrane Register of Diagnostic Test Accuracy Studies, which is currently managed using Reference Manager.

It is planned that files for importing references that have been downloaded from MEDLINE (PubMed and Ovid formats) and EMBASE (Ovid format) into reference management

software will be made available from the Cochrane Systematic Reviews of Diagnostic Test Accuracy website:

- srdta.cochrane.org/

7.5.2 Which fields to download from databases and import into reference management software

The **full record citation** should be downloaded: author(s), title (including the original title in languages other than English where this is available), source (e.g. journal title), volume, issue, page number(s), together with the **abstract**, where available. Information in abstracts can be helpful in eliminating clearly irrelevant reports, removing the need to obtain the full text of the article. In addition, we recommend the following fields be considered for downloading from databases where they are available:

- **Accession number / Unique identifier:** it is advisable to set aside an unused field for storing the accession number or unique identifier of records downloaded, such as the PubMed ID number (PMID). This allows subsequent linkage to the full database record and also facilitates information management such as duplicate detection and record removal.
- **Affiliation / address:** this may include the institutional affiliation and / or e-mail address of the author(s) which can be useful if Cochrane authors need to contact the corresponding author to request further information.
- **Article identifier / digital object identifier(DOI):** this can be used to cite and link to the full text of the article.
- **Comments, corrections, errata, retractions and updates:** it is important to ensure that any fields that relate to subsequently published comments, corrections, errata, retractions and updates are included in the downloads so that any impact of these subsequent publications can be taken into account (Royle 2004; Sox 2006) when including studies for the review or updating the review. Important fields to consider, together with their field labels in PubMed, are provided in Box 7.5.a.
- **ISSN:** the international standard serial number is a unique identifier for the journal and is useful to help track down difficult to locate journals, if the full text of the study is required.
- **Language:** it is helpful to know the language of publication of the original study if translations are required.
- **Subject headings / thesaurus terms/ keywords:** See Section 7.4.5. These help indicate why records were retrieved if the title and abstract lack detail. They can also be helpful to inform future searches for updating the review.

Box 7.5.a: Fields in PubMed relating to subsequently published comments, corrections, errata, retractions and updates

CIN:	'Comment in'
CON:	'Comment on'
CRI:	'Corrected and republished in'
CRF:	'Corrected and republished from'
EIN:	'Erratum in'
EFR:	'Erratum for'
PRIN:	'Partial retraction in'
PROF:	'Partial retraction of'

RIN:	'Retraction in'
ROF:	'Retraction of '
RPI:	'Republished in'
RPF:	'Republished from'
UIN:	'Update in'
UOF:	'Update of'

7.5.3 Summary points

- Cochrane review authors should find it helpful to use reference management software to manage records retrieved by the searches for their review;
- Ensure that the full citation of records retrieved by the searches is downloaded together with the abstract, where available, and any additional information likely to be helpful for deciding on relevance and appropriateness, as well as for documenting and reporting the search process.

7.6 Documenting and reporting the search process

7.6.1 Documenting the search process

The search process needs to be documented in enough detail throughout the process to ensure that it can be reported in full in the review and to enable all the searches to be reproducible. It is recommended that authors seek advice from the Trials Search Co-ordinator of the Cochrane Review Group on documenting the search process in the review before starting searching. Careful documentation of the search process is especially important for diagnostic test accuracy reviews as it will help to provide insight into the best sources of studies and give an overview of the likely sources of bias if searches were to be restricted to specific databases, to specific languages or to published papers only. Incomplete reporting of systematic reviews of diagnostic test accuracy has been found to compromise reliability and relevance (Irwig 1994; Schmid 2004; Whiting 2005; Mallett 2006; Moher 2007b).

We recommend that authors document the search process (sources searched, search strategies used, number of citations found in each electronic database searched, number of potentially eligible studies identified after screening titles and abstracts, number of studies for which full reports were retrieved, number of studies identified from checking reference lists, handsearching and other search methods, number of studies finally included in the analysis of the review) at each stage during the process for final reporting in the systematic review. Studies for which reports were retrieved based on title and abstract, but finally excluded based on the full-text article, should also be listed and the key reason for exclusion given.

Studies for which insufficient information is available to include them or exclude them from the review, should also be reported. For example, translations may be awaited or confirmation of details from authors required.

It is advisable to save locally or print and file copies of any information found on the internet, such as information about ongoing research, as this may no longer be accessible at the time the review is written up.

Full search strategies for each database will need to be included in an appendix to the review, ideally copied and pasted from the original search strategies, and an overview of the search results and selection process will need to be summarized in the 'Results of the search' section (see Chapter 4, Section 4.5) . Guidelines (Moher 1999) for the reporting of meta-analyses of randomized controlled trials (QUOROM recently revised as PRISMA) include a flow

diagram (http://www.consort-statement.org/mod_product/uploads/QUOROM%20checklist%20and%20flow%20diagram%201999.pdf) that authors may wish to adapt for reporting results of searches for studies for diagnostic test accuracy reviews (see Figure 7.6.a below for a suggested format).

7.6.2 Reporting the search process

7.6.2.1 Reporting the search process in the protocol

The inclusion of any search strategies in the protocol for a Cochrane systematic review of diagnostic test accuracy is optional. Where searches have already been undertaken at the protocol stage it may be considered useful to include them in an appendix to the protocol so that they can be commented upon in the same way as other aspects of the protocol.

7.6.2.2 Reporting the search process in the review

Reporting the search process in the structured abstract of the review (see Chapter 4, Section 4.3)

Under the heading 'Search methods' and using the form "We searched…":

- list the databases searched and the date ranges covered (e.g. MEDLINE (January 1950 to June 2008), EMBASE (January 1980 to June 2008);
- state whether bibliographies were searched, using the phrase "reference lists of articles", and whether citation searches were conducted;
- state restrictions based on language or publication status if any;
- list any journals or conference proceedings that were handsearched and the date ranges covered;
- state whether individuals or organizations such as test manufacturers were contacted to locate other published, unpublished or ongoing studies using the phrase "We contacted test manufacturers".

Reporting the search process in the methods section of the review (see Chapter 4, Section 4.5)

The methods used to identify studies should be summarized under the section 'Search methods for identification of studies'.

Under the heading 'Electronic searches':

- list all the databases searched, the service provider used and the date ranges covered (e.g. MEDLINE using Ovid (January 1950 to June 2008), EMBASE using Ovid (January 1980 to June 2008) and note the dates of the last search for each database (e.g. 27 June 2008)
- state restrictions based on language, if any;
- include the full search strategies for each database (preferably copied and pasted from the original saved search strategies rather than retyped) as an appendix to the review.

Under the heading 'Searching other resources':

- state whether grey literature sources were searched (e.g. conference proceedings, report literature, dissertations etc);
- list any journals or conference proceedings specifically handsearched for the review and the date range searched (e.g. Journal of Medical Screening January 1994 to June 2008; annual scientific meetings of the Society for Pediatric Research 1980 to 2007);
- state whether reference lists of relevant studies and other related diagnostic test accuracy reviews were searched;
- list the sources used to conduct citation searches such as the 'Related Articles' feature in PubMed or the 'Find Similar' option in Ovid, or Science Citation Index, Scopus, Google Scholar, etc;
- list individuals or organizations who were contacted for information on additional published, unpublished or ongoing studies, for example, such as test manufacturers, other researchers or experts in the field;

- List any other sources such as internet searches (include details of the website URL and date searched), personal collections of articles, etc.

If preferred, the above information can be reported under four subheadings either in place of 'Searching other resources' or as subheadings to it:

- Grey literature
- Handsearching
- Reference lists
- Correspondence

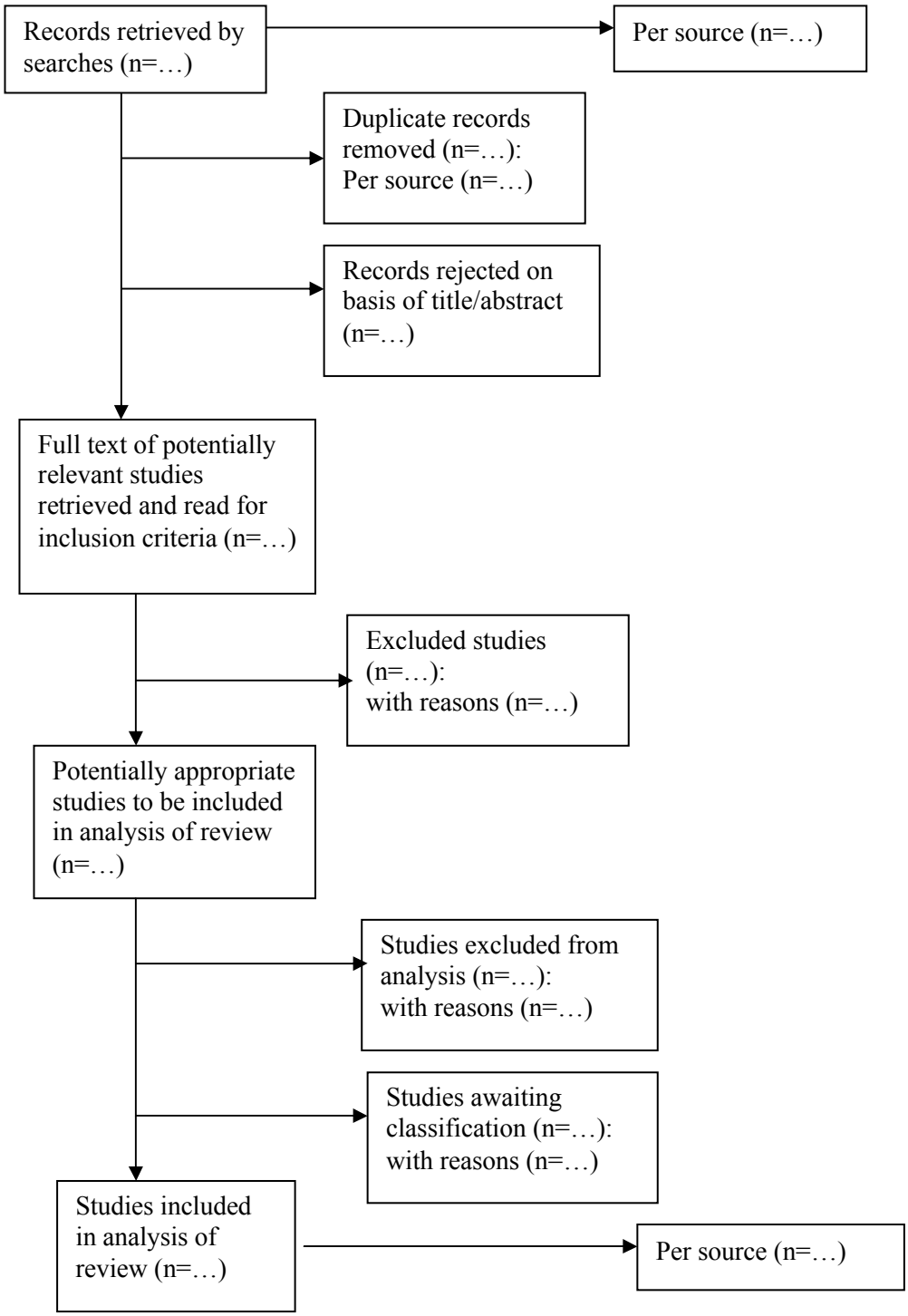
Reporting the search process in the results section of the review (see Chapter 4, Section 4.5)

Under the heading 'Results of the search' a summary of the results of the searches conducted for the review should be given, reporting the:

- total number of citations identified by the electronic searches and other methods;
- number of citations considered potentially eligible after screening titles and abstracts;
- number of citations for which full reports were retrieved;
- number of reports identified by other methods (such as handsearching, checking reference lists, citation searches, correspondence, etc.), where possible;
- number of reports that were finally included in the analysis of the review.

Authors may wish to summarize this overview of the search and selection process by using a flow diagram, included as an additional Figure (see Figure 7.6.a for a possible format).

Figure 7.6.a: Results of the search (possible format as a flow diagram).



Reporting the search process in an appendix to the review (see Chapter 4, Section 4.12)

Include the full search strategies for each database searched (preferably copied and pasted from the original saved search strategies rather than retyped) in an appendix to the review.

7.6.3 Summary points

- Seek guidance on documenting the search process from the Trials Search Co-ordinator of the Cochrane Review Group before starting searching as a variety of data needs to be recorded at stages during the search process for final reporting in the review;
- The full search strategies for each database searched should be copied and pasted into an appendix to the review;
- An overview of the search and selection process should be given in the results section (in the form of a descriptive paragraph or flow diagram as an additional Figure) including the total number of citations retrieved by the searches and the number of studies included in the analysis of the review;
- Save locally or print and file copies of any information found on the internet, such as information about ongoing research as it may no longer be accessible at the time of writing up the review;
- Refer also to Chapter 4 for more information on what to report in the protocol and review.

7.7 Contributions to this chapter

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7.8 References

Alldred 2006
Alldred S, Hampson L, Neilson J, Alfirevic Z, Deeks J. Comparison of two different search strategies in identifying literature for a diagnostic test accuracy review of Down's Syndrome screening [abstract]. *XIV Cochrane Colloquium*; 2006 Oct 23-26; Dublin, Ireland: 57.

Astin 2008
Astin MP, Brazzelli MG, Fraser CM, Counsell CE, Needham G, Grimshaw JM. Developing a sensitive search strategy in MEDLINE to retrieve studies on assessment of the diagnostic performance of imaging techniques. *Radiology* 2008; 247:365-73.

Bachmann 2002
Bachmann LM, Coray R, Estermann P, ter Riet G. Identifying diagnostic studies in MEDLINE: reducing the Number Needed to Read. *Journal of the American Medical Informatics Association* 2002; 9: 653-8.

Bachmann 2003
Bachmann LM, Estermann P, Kronenberg C, ter Riet G. Identifying diagnostic accuracy studies in EMBASE. *Journal of the Medical Library Association* 2003; 91: 341-6.

Barrowman 2003
Barrowman NJ, Fang, Sampson M, Moher D. Identifying null meta-analyses that are ripe for updating. *BMC Medical Research Methodology* 2003; 3: 13.

Bayliss 2008
Bayliss S, Davenport C. Locating systematic reviews of test accuracy studies: how five specialist review databases measure up. *International Journal of Technology Assessment in Health Care* 2008; 24(4): in press.

Begg 1988
Begg CB. Methodologic standards for diagnostic test assessment studies. *Journal of General Internal Medicine* 1988; 3: 518-20.

Berg 2005
Berg A, Fleischer S, Behrens J. Development of two search strategies for literature in MEDLINE-PubMed: nursing diagnoses in the context of evidence-based nursing. *International Journal of Nursing Terminologies and Classifications* 2005; 16: 26-32.

Bossuyt 2003a
Bossuyt PM, Reitsma JB, Bruns DE, Gatsonis CA, Glasziou PP, Irwig LM, Lijmer JG, Moher D, Rennie D, de Vet HC. Towards complete and accurate reporting of studies of diagnostic accuracy: the STARD initiative. *BMJ* 2003; 326: 41-4.

Bossuyt 2003b
Bossuyt PM, Reitsma JB, Bruns DE, Gatsonis CA, Glasziou PP, Irwig LM, Moher D, Rennie D, de Vet HC, Lijmer JG. The STARD statement for reporting studies of diagnostic accuracy: explanation and elaboration. *Annals of Internal Medicine* 2003; 138: W1-12.

Boynton 1998
Boynton J, Glanville J, McDaid D, Lefebvre C. Identifying systematic reviews in MEDLINE: developing an objective approach to search strategy design. *Journal of Information Science* 1998; 24: 137-54.

Brazier 1999
Brazier H, Murphy AW, Lynch C, Bury G. Searching for the evidence in pre-hospital care: a review of randomised controlled trials. *Journal of Accident and Emergency Medicine* 1999; 16: 18-23.

Brazzelli 2006
Brazzelli M, Sandercock P, Deeks J. Publication bias and diagnostic research: full publication of results initially presented in abstracts [abstract]. *XIV Cochrane Colloquium*; 2006 Oct 23-26; Dublin, Ireland: 86.

Brazzelli 2008

Brazzelli M, Sandercock P, Lewis S, Deeks J. Publication bias in studies of diagnostic accuracy in the stroke literature. What is the evidence? [abstract]. In: *Methods for Evaluating Medical Tests. Symposium*; 2008 Jul 24-25; Department of Public Health, Epidemiology and Biostatistics, University of Birmingham, Birmingham, UK: 21.

Critical Appraisal Skills Programme 2006
Critical Appraisal Skills Programme. Search filters. Oxford: Public Health Resource Unit, 2006. Available from: http://www.phru.nhs.uk/casp/search_filters.htm (accessed 31 August 2006).

Davenport 2008
Davenport C, Bayliss S. The epidemiology of reviews of test performance: an analysis of the content of five specialist review databases [abstract]. In: *Methods for Evaluating Medical Tests. Symposium*; 2008 Jul 24-25; Department of Public Health, Epidemiology and Biostatistics, University of Birmingham, Birmingham, UK: 39.

Devillé 2000
Devillé WLJM, Bezemer PD, Bouter LM. Publications on diagnostic test evaluation in family medicine journals: an optimal search strategy. *Journal of Clinical Epidemiology* 2000; 53: 65-9.

Devillé 2002a
Devillé WL, Buntinx F. Guidelines for conducting systematic reviews of studies evaluating the accuracy of diagnostic tests. In: Knottnerus JA, editor. *The evidence base of clinical diagnosis.* London: BMJ Books, 2002: 145-65.

Devillé 2002b
Devillé WL, Buntinx F, Bouter LM, Montori VM, de Vet HC, van der Windt DA, Bezemer PD. Conducting systematic reviews of diagnostic studies: didactic guidelines. *BMC Medical Research Methodology* 2002; 2: 9.

Diagnostic Procedures 2002
Diagnostic Procedures [online resource]. Available from: http://www.londonlinks.ac.uk/evidence_strategies/ovid_filters.htm (accessed 31 August 2003).

Dickersin 1994
Dickersin K, Scherer R, Lefebvre C. Identifying relevant studies for systematic reviews. *BMJ* 1994; 309: 1286-91.

Dickersin 1997
Dickersin K. How important is publication bias? A synthesis of available data. *AIDS Education and Prevention* 1997; 9(1 Suppl): 15-21.

Dickersin 2005
Dickersin K. Publication bias: recognizing the problem, understanding its origins and scope, and preventing harm. In: Rothstein HR, Sutton AJ, Borenstein M, editors. *Publication bias in meta-analysis: prevention, assessment and adjustments*. Chichester, UK: John Wiley & Sons, Ltd, 2005: 11-33.

Doust 2005
Doust JA, Pietrzak E, Sanders S, Glasziou PP. Identifying studies for systematic reviews of diagnostic tests was difficult due to the poor sensitivity and precision of methodologic filters and the lack of information in the abstract. *Journal of Clinical Epidemiology* 2005; 58: 444-9.

Easterbrook 1991
Easterbrook PJ, Berlin JA, Gopalan R, Matthews DR. Publication bias in clinical research. *Lancet* 1991; 337: 867-72.

Egger 1997
Egger M, Zellweger-Zähner T, Schneider M, Junker C, Lengeler C, Antes G. Language bias in randomised controlled trials published in English and German. *Lancet* 350: 326-9.

Egger 1998
Egger M, Smith GD. Bias in location and selection of studies. *BMJ* 1998; 316: 61-6.

Egger 2003
Egger M, Jüni P, Bartlett C, Holenstein F, Sterne J. How important are comprehensive literature searches and the assessment of trial quality in systematic reviews? Empirical study. *Health Technology Assessment* 2003; 7(1): 1-68.

Eysenbach 2001
Eysenbach G, Tuische J, Diepgen TL. Evaluation of the usefulness of Internet searches to identify unpublished clinical trials for systematic reviews. *Medical Informatics and the Internet in Medicine* 2001; 26: 203-18.

Eysenbach 2005
Eysenbach G, Trudel M. Going, going, still there: using the WebCite service to permanently archive cited web pages. *Journal of Medical Internet Research* 2005; 7: e60.

Falck-Ytter 2004
Falck-Ytter YT, Motschall E. New search filter for diagnostic studies: Ovid and PubMed versions not the same. *BMJ* 2004; 328: 1040.

Fielding 2002
Fielding AM, Powell A. Using MEDLINE to achieve an evidence-based approach to diagnostic clinical biochemistry. *Annals of Clinical Biochemistry* 2002; 39: 345-50.

Franceschini 2006
Franceschini R, Trevisiol C, Valentini M, Pistotti V. Identifying studies on diagnostic tests in oncology: the prostate-specific antigen (PSA) experience [abstract]. *XIV Cochrane Colloquium*; 2006 Oct 23-26; Dublin, Ireland: 87.

Fraser 2006
Fraser C, Mowatt G, Siddiqui R, Burr J. Searching for diagnostic test accuracy studies: an application to screening for open angle glaucoma (OAG) [abstract]. *XIV Cochrane Colloquium*; 2006 Oct 23-26; Dublin, Ireland: 88.

Glanville 2007
Glanville J. Searching for diagnostic tests: which databases, which filters? *Fourth Annual Meeting of Health Technology Assessment International (HTAi): Pushing the frontiers of information management*; 2007 Jun 17-20; Barcelona, Spain: 14.

Glanville 2008a
Glanville J, Bayliss S, Booth A, Dundar Y, Fleeman ND, Foster L, Fraser C, Fernandes H, Fry-Smith A, Golder S, Lefebvre C, Miller C, Paisley S, Payne L, Price AM, Welch K; InterTASC Information Specialists' Subgroup. So many filters, so little time: The development of a Search Filter Appraisal Checklist. *Journal of the Medical Library Association* 2008; in press.

Glanville 2008b
Glanville J, Ritchie G, Lefebvre C. How well do published search filters perform in finding diagnostic test accuracy studies? [abstract]. In: *Methods for Evaluating Medical Tests. Symposium*; 2008 Jul 24-25; Department of Public Health, Epidemiology and Biostatistics, University of Birmingham, Birmingham, UK: 18.

Golder 2006
Golder S, McIntosh HM, Duffy S, Glanville J; Centre for Reviews and Dissemination and UK Cochrane Centre Search Filters Design Group. Developing efficient search strategies to identify reports of adverse effects in MEDLINE and EMBASE. *Health Information and Libraries Journal* 2006; 23: 3-12.

Gøtzsche 1987
Gøtzsche P. Reference bias in reports of drug trials. *British Medical Journal (Clinical Research Edition)* 1987; 295: 654-6.

Greenhalgh 2005
Greenhalgh T, Peacock R. Effectiveness and efficiency of search methods in systematic reviews of complex evidence: audit of primary sources. *BMJ* 2005; 331: 1064-5.

Haynes 1994
Haynes RB, Wilczynski NL, McKibbon KA, Walker CJ, Sinclair JC. Developing optimal search strategies for detecting clinically sound studies in MEDLINE. *Journal of the American Medical Informatics Association* 1994; 1: 447-58.

Haynes 2004
Haynes RB, Wilczynski NL; McMaster Hedges Team. Optimal search strategies for retrieving scientifically strong studies of diagnosis from MEDLINE: analytical survey. *BMJ* 2004; 328: 1040-2.

Honest 2002
Honest H, Khan KS. Reporting of measures of accuracy in systematic reviews of diagnostic literature. *BMC Health Services Research* 2002*;* 2: 4.

Hopewell 2002
Hopewell S, Clarke M, Lusher A, Lefebvre C, Westby M. A comparison of handsearching versus MEDLINE searching to identify reports of randomized controlled trials. *Statistics in Medicine* 2002; 21: 1625-34.

Hopewell 2003
Hopewell S. Assessing the impact of abstracts from the Thoracic Society of Australia and New Zealand in Cochrane reviews. *Respirology* 2003; 8: 509-12.

Hopewell 2005
Hopewell S, Clarke M, Mallett S. Grey literature and systematic reviews. In: Rothstein HR, Sutton AJ, Borenstein M, editors. *Publication bias in meta-analysis: prevention, assessment and adjustments.* Chichester, UK: John Wiley & Sons, Ltd, 2005: 49-72.

Hopewell 2007a
Hopewell S, Clarke MJ, Lefebvre C, Scherer RW. Handsearching versus electronic searching to identify reports of randomized trials. *Cochrane Database of Systematic Reviews* 2007, Issue 2. Art. No.: MR000001. DOI: 10.1002/14651858.MR000001.pub2.

Hopewell 2007b

Hopewell S, McDonald S, Clarke M, Egger M. Grey literature in meta-analyses of randomized trials of healthcare interventions. *Cochrane Database of Systematic Reviews* 2007, Issue 2. Art. No.: MR000010. DOI: 10.1002/14651858.MR000010.pub3.

Iansavichene 2008
Iansavichene AE, Sampson M, McGowan J, Ajiferuke ISY. Should systematic reviewers search for randomized, controlled trials published as letters? [letter] *Annals of Internal Medicine* 2008; 148: 714-5.

Information Service, Centre for Reviews and Dissemination 2008
Information Service, Centre for Reviews and Dissemination. *Finding studies for systematic reviews: a checklist for researchers* [updated April 2008]. York: Centre for Reviews and Dissemination, 2008. Available from: http://www.york.ac.uk/inst/crd/revs.htm (accessed 09 July 2008).

InterTASC Information Specialists' Subgroup 2006
InterTASC Information Specialists' Subgroup. *Search filter resource: search filters to identify tests of diagnostic accuracy provided by members of InterTASC.* York: Centre for Reviews and Dissemination, 2006. Available from: http://www.york.ac.uk/inst/crd/intertasc/test-jmg.htm (accessed 31 October 2007).

Irwig 1994
Irwig L, Tosteson AN, Gatsonis C, Lau J, Colditz G, Chalmers TC, Mosteller F. Guidelines for meta-analyses evaluating diagnostic tests. *Annals of Internal Medicine* 1994; 120: 667-76.

Irwig 1995
Irwig L, Macaskill P, Glasziou P, Fahey M. Meta-analytic methods for diagnostic test accuracy. *Journal of Clinical Epidemiology* 1995; 48: 119-30; discussion 131-2.

Jüni 2002
Jüni P, Holenstein F, Sterne J, Bartlett C, Egger M. Direction and impact of language bias in meta-analyses of controlled trials: empirical study. *International Journal of Epidemiology* 2002; 31: 115-23.

Kjaergard 2002
Kjaergard LL, Gluud C. Citation bias of hepato-biliary randomized clinical trials. *Journal of Clinical Epidemiology* 2002; 55: 407-10.

Kleijnen 1992
Kleijnen J, Knipschild P. The comprehensiveness of MEDLINE and EMBASE computer searches. Searches for controlled trials of homeopathy, ascorbic acid for common cold and ginkgo biloba for cerebral insufficiency and intermittent claudication. *Pharmaceutisch Weekblad Scientific Edition* 1992; 14: 316-20.

Kloda 2007
Kloda LA. Evidence summary: use Google Scholar, Scopus and Web of Science for comprehensive citation tracking. *Evidence Based Library and Information Practice* 2007; 2: 87-90.

Leeflang 2006
Leeflang MMG, Scholten RJPM, Rutjes AWS, Reitsma JB, Bossuyt PMM. Use of methodological search filters to identify diagnostic accuracy studies can lead to the omission of relevant studies. *Journal of Clinical Epidemiology* 2006; 59: 234-40.

Leeflang 2007

Leeflang M, McDonald S, Scholten RJPM, Reitsma H, Rutjes AWS. Search strategies to identify diagnostic accuracy studies in MEDLINE and EMBASE (Protocol). *Cochrane Database of Systematic Reviews* 2007, Issue 2. Art. No.: MR000022. DOI:10.1002/14651858.MR000022.pub2.

Leeflang 2008a
Leeflang MMG. Chapter 5: Diagnostic accuracy may vary with prevalence: implications for evidence-based diagnosis. In: Leeflang MMG. *Systematic reviews of diagnostic test accuracy*. PhD Thesis. Amsterdam, The Netherlands: University of Amsterdam, 2008.

Leeflang 2008b
Leeflang M, Bossuyt P, Irwig L. Reasons why sensitivity and specificity do vary with disease prevalence [abstract]. In: *Methods for Evaluating Medical Tests. Symposium*; 2008 Jul 24-25; Department of Public Health, Epidemiology and Biostatistics, University of Birmingham, Birmingham, UK: 19.

Lefebvre 2008
Lefebvre C, Manheimer E, Glanville JM. Chapter 6: Searching for studies. In: Higgins JPT, Green S (editors), *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.0.0 (updated February 2008). The Cochrane Collaboration, 2008. Available from: www.cochrane.org/resources/handbook.

Lijmer 1999
Lijmer JG, Mol BW, Heisterkamp S, Bonsel GJ, Prins MH, van der Meulen JH, Bossuyt PM. Empirical evidence of design-related bias in studies of diagnostic tests. *JAMA* 1999; 282: 1061-6.

Mallett 2002
Mallett S, Hopewell S, Clarke M. Grey literature in systematic reviews: the first 1000 Cochrane systematic reviews. *The Cochrane Collaboration Methods Groups Newsletter* 2002; 6: 16.

Mallett 2006
Mallett S, Deeks JJ, Halligan S, Hopewell S, Cornelius V, Altman DG. Systematic reviews of diagnostic tests in cancer: review of methods and reporting. *BMJ* 2006; 333: 413-6.

McAuley 2000
McAuley L, Pham B, Tugwell P, Moher D. Does the inclusion of grey literature influence estimates of intervention effectiveness reported in meta-analysis? *Lancet* 2000; 356 :1228-31.

McDonald 1999
McDonald S, Taylor L, Adams C. Searching the right database. A comparison of four databases for psychiatry journals. *Health Libraries Review* 1999; 16: 151-6.

McDonald 2002
McDonald S, Lefebvre C, Antes G, Galandi D, Gøtzsche P, Hammarquist C, Haugh M, Jensen KL, Kleijnen J, Loep M, Pistotti V, Rüther A. The contribution of handsearching European general healthcare journals to the Cochrane Controlled Trials Register. *Evaluation and the Health Professions* 2002; 25: 65-75.

McKibbon 2002
McKibbon KA. CASP: searching for the best evidence in clinical journals [online resource]. Available from: http://www.minervation.com/cebm/docs/searching.html (accessed 31 August 2006).

Mijnhout 2000
Mijnhout GS, Hooft L, van Tulder MW, Devillé WL, Teule GJ, Hoekstra OS. How to perform a comprehensive search for FDG-PET literature. *European Journal of Nuclear Medicine* 2000; 27: 91-7.

Mijnhout 2004
Mijnhout GS, Riphagen II, Hoekstra OS. Update of the FDG PET search strategy. *Nuclear Medicine Communications* 2004; 25: 1187-9.

Minozzi 2000
Minozzi S, Pistotti V, Forni M. Searching for rehabilitation articles on MEDLINE and EMBASE. An example with cross-over design. *Archives of Physical Medicine and Rehabilitation* 2000; 81: 720-2.

Mitchell 2005
Mitchell R, Rinaldi F, Craig J. Performance of published search strategies for studies of diagnostic test accuracy (SDTAs) in MEDLINE and EMBASE [abstract]. *XIII Cochrane Colloquium*; 2005 Oct 22-26; Melbourne, Australia: 33. Available from: http://www.cochrane.org/colloquia/abstracts/melbourne/O-01.htm (accessed 31 October 2007).

Moher 1996
Moher D, Fortin P, Jadad AR, Jüni P, Klassen T, Le Lorier J, Liberati A, Linde K, Penna A. Completeness of reporting of trials published in languages other than English: implications for conduct and reporting of systematic reviews. *Lancet* 1996; 347: 363-6.

Moher 1999
Moher D, Cook DJ, Eastwood S, Olkin I, Rennie D, Stroup DF. Improving the quality of reports of meta-analyses of randomised controlled trials: the QUOROM statement. *Lancet* 354: 1896-900.

Moher 2000
Moher D, Pham B, Klassen TP, Schulz KF, Berlin JA, Jadad AR, Liberati A. What contributions do languages other than English make on the results of meta-analyses? *Journal of Clinical Epidemiology* 2000; 53: 964-72.

Moher 2003
Moher D, Pham B, Lawson ML, Klassen TP. The inclusion of reports of randomised trials published in languages other than English in systematic reviews. *Health Technology Assessment* 2003; 7(41): 1-90.

Moher 2007a
Moher D, Tsertsvadze A, Tricco AC, Eccles M, Grimshaw J, Sampson M, Barrowman N. A systematic review identified few methods and strategies describing when and how to update systematic reviews. *Journal of Clinical Epidemiology* 2007; 60: 1095-1104.

Moher 2007b
Moher D, Tetzlaff JJ, Tricco AC, Sampson M, Altman DG. Epidemiology and reporting characteristics of systematic reviews. *PloS Medicine* 2007; 4: e78.

Montori 2005
Montori VM, Wilczynski NL, Morgan D, Haynes RB; McMaster Hedges Team. Optimal search strategies for retrieving systematic reviews from MEDLINE: analytical survey. *BMJ* 2005; 330: 68-73.

National Library of Medicine 2007
National Library of Medicine. Search strategy used to create the systematic reviews subset on PubMed [updated Feb 2007]. Available from: http://www.nlm.nih.gov/bsd/pubmed_subsets/sysreviews_strategy.html (accessed 24 October 2007).

Pham 2005
Pham B, Klassen TP, Lawson ML, Moher D. Language of publication restrictions in systematic reviews gave different results depending on whether the intervention was conventional or complementary. *Journal of Clinical Epidemiology* 2005; 58: 769-76.

Ramos-Remus 1994
Ramos-Remus C, Suarez-Almazor M, Dorgan M, Gomez-Vargas A, Russell AS. Performance of online biomedical databases in rheumatology. *Journal of Rheumatology* 21: 1912-21.

Ravnskov 1992
Ravnskov U. Cholesterol lowering trials in coronary heart disease: frequency of citation and outcome. *BMJ* 1992; 305: 15-9.

Ravnskov 1995
Ravnskov U. Quotation bias in reviews of the diet-heart idea. *Journal of Clinical Epidemiology* 1995; 48: 713-9.

Reveiz 2006
Reveiz L, Cardona AF, Ospina EG, de Agular S. An e-mail survey identified unpublished studies for systematic reviews. *Journal of Clinical Epidemiology* 2006; 59: 755-8.

Ritchie 2007
Ritchie G, Glanville J, Lefebvre C. Do published search filters to identify diagnostic test accuracy studies perform adequately? *Health Information and Libraries Journal* 2007; 24: 188-92.

Royle 2004
Royle P, Waugh N. Should systematic reviews include searches for published errata? *Health Information and Libraries Journal* 2004; 21: 14-20.

Royle 2005
Royle PL, Bain L, Waugh NR. Sources of evidence for systematic reviews of interventions in diabetes. *Diabetic Medicine* 2005; 22: 1386-93.

Sampson 2003
Sampson M, Barrowman NJ, Moher D, Klassen TP, Pham B, Platt R, St John PD, Viola R, Raina P. Should meta-analysts search EMBASE in addition to MEDLINE? *Journal of Clinical Epidemiology* 2003; 56: 943-55.

Sampson 2008
Sampson M, Shojania KG, McGowan J, Daniel R, Rader T, Iansavichene AE, Ji J, Ansari MT, Moher D. Surveillance search techniques identified the need to update systematic reviews. *Journal of Clinical Epidemiology* 2008; 61: 755-62.

Savoie 2003
Savoie I, Helmer D, Green CJ, Kazanjian A. Beyond MEDLINE: reducing bias through extended systematic review search. *International Journal of Technology Assessment in Health Care* 2003; 19: 168-78.

Scherer 2007
Scherer RW, Langenberg P, von Elm E. Full publication of results initially presented in abstracts. *Cochrane Database of Systematic Reviews* 2007, Issue 2. Art. No.: MR000005. DOI: 10.1002/14651858.MR000005.pub3.

Schmid 2004
Schmid C, Chung M, Chew P, Lau J. Survey of diagnostic test meta-analyses [abstract]. *XII Cochrane Colloquium*; 2004 Oct 2-6; Ottawa, Ontario, Canada :50-1.

Shipley 2002
Shipley MC. *Evidence-based filters for Ovid MEDLINE*. Rochester, NY: Edward G Miner Library, University of Rochester, 2002. Available from: http://www.urmc.rochester.edu/hslt/miner/digital_library/tip_sheets/OVID_eb_filters.pdf (accessed 31 October 2007).

Shojania 2001
Shojania KG, Bero LA. Taking advantage of the explosion of systematic reviews: an efficient MEDLINE search strategy. *Effective Clinical Practice* 2001; 4: 157-62.

Simel 2008
Simel DL, Rennie D, Bossuyt PM. The STARD statement for reporting diagnostic accuracy studies: application to the history and physical examination. *Journal of General Internal Medicine* 2008; 23: 768-74.

Smart 1964
Smart RG. The importance of negative results in psychological research. *Canadian Psychologist* 1964; 5: 225-32.

Smidt 2006
Smidt N, Rutjes AW, van der Windt DA, Ostelo RW, Bossuyt PM, Reitsma JB, Bouter LM, de Vet HC. The quality of diagnostic studies since the STARD statement: has it improved? *Neurology* 2006; 67: 792-7.

Smith 1980
Smith ML. Sex bias in counselling and psychotherapy. *Psychological Bulletin* 1980; 87: 392-407.

Smith 1992
Smith BJ, Darzins PJ, Quinn M, Heller RF. Modern methods of searching the medical literature. *Medical Journal of Australia* 1992; 157: 603-11.

Song 2000
Song F, Eastwood AJ, Gilbody S, Duley L, Sutton AJ. Publication and related biases. *Health Technology Assessment* 2000; 4(10): 1-115.

Song 2002
Song F, Khan KS, Dinnes J, Sutton AJ. Asymmetric funnel plots and publication bias in meta-analyses of diagnostic test accuracy. *International Journal of Epidemiology* 2002; 31: 88-95.

Sox 2006
Sox HC, Rennie D. Research misconduct, retraction, and cleansing the medical literature: lessons from the Poehlman case. *Annals of Internal Medicine* 2006; 144: 609-13.

Suarez-Almazor 2000

Suarez-Almazor ME, Belseck E, Homik J, Dorgan M, Ramos-Remus C. Identifying clinical trials in the medical literature with electronic databases: MEDLINE alone is not enough. *Controlled Clinical Trials* 2000; 21: 476-87.

Topfer 1999
Topfer LA, Parada A, Menon D, Noorani H, Perras C, Serra-Prat M. Comparison of literature searches on quality and costs for health technology assessment using the MEDLINE and EMBASE databases. *International Journal of Technology Assessment in Health Care* 1999; 15: 297-303.

van der Weijden 1997
van der Weijden T, Ijzjermans CJ, Dinant GJ, van Duijn NP, de Vet R, Buntinx F. Identifying relevant diagnostic studies in MEDLINE. The diagnostic value of the erythrocyte sedimentation rate (ESR) and dipstick as an example. *Family Practice* 1997; 14: 204-8.

Vincent 2003
Vincent S, Greenley S, Beaven O. Clinical Evidence diagnosis: developing a sensitive search strategy to retrieve diagnostic studies on deep vein thrombosis: a pragmatic approach. *Health Information and Libraries Journal* 2003; 20: 150-9.

Vogel 2000
Vogel U, Windeler J. Factors modifying the frequency of publications of clinical research results exemplified by medical dissertations [Einflussfaktoren auf die Publikationschäfigkeit klinischer Forschungsergebnisse am Beispiel medizinischer Dissertationen]. *Deutsche Medizinische Wochenschrift* 2000; 125: 110-3.

White 2001
White VJ, Glanville JM, Lefebvre C, Sheldon TA. A statistical approach to designing search filters to find systematic reviews: objectivity enhances accuracy. *Journal of Information Science* 2001; 27: 357-70.

Whiting 2005
Whiting P, Rutjes AW, Dinnes J, Reitsma JB, Bossuyt PM, Kleijnen J. A systematic review finds that diagnostic reviews fail to incorporate quality despite available tools. *Journal of Clinical Epidemiology* 2005; 58: 1-12.

Whiting 2008a
Whiting P, Westwood M, Burke M, Sterne J, Glanville J. Systematic reviews of test accuracy should search a range of databases to identify primary studies. *Journal of Clinical Epidemiology* 2008; 61: 357-64.

Whiting 2008b
Whiting P, Westwood M, Burke M, Sterne J, Harbord R, Glanville J. Can diagnostic filters offer similar sensitivity and a reduced number needed to read compared to searches based on index test and target condition? [abstract]. In: *Methods for Evaluating Medical Tests. Symposium*; 2008 Jul 24-25; Department of Public Health, Epidemiology and Biostatistics, University of Birmingham, Birmingham, UK: 20.

Wilczynski 1995
Wilczynski NL, Walker CJ, McKibbon KA, Haynes RB. Reasons for the loss of sensitivity and specificity of methodologic MeSH terms and textwords in MEDLINE. *Proceedings of the Annual Symposium on Computer Applications in Medical Care* 1995: 436-40.

Wilczynski 2007

Wilczynski NL, Haynes RB; McMaster Hedges Team. EMBASE search strategies achieved high sensitivity and specificity for retrieving methodologically sound systematic reviews. *Journal of Clinical Epidemiology* 2007; 60: 29-33.

Wong 2006a
Wong SS, Wilczynski NL, Haynes RB; McMaster Hedges Team. Comparison of top-performing search strategies for detecting clinically sound treatment studies and systematic reviews in MEDLINE and EMBASE. *Journal of the Medical Library Association* 2006; 94: 451-5.

Wong 2006b
Wong SS, Wilczynski NL, Haynes RB; McMaster Hedges Team. Optimal CINAHL search strategies for identifying therapy studies and review articles. *Journal of Nursing Scholarship* 2006; 38: 194-9.

Zimpel 2000
Zimpel T, Windeler J. Publication of dissertations on therapeutic and diagnostic procedures in complementary and alternative medicine – a contribution to 'publication bias' [Veröffentlichungen von Dissertationen zu unkonventionellen medizinischen Therapie- und Diagnoseverfahren – ein Beitrag zum 'publication bias']. *Forschung zu Komplementärmedizin und Klassischer Naturheilkunde* 2000; 7: 71-4.