

## EXTERNAL SCIENTIFIC REPORT

# Technical Manual for Performing Electronic Literature Searches in Food and Feed Safety

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### ABSTRACT

Regulation (EC) No 178/2002 recommends that risk assessments are undertaken by the European Food Safety Authority (EFSA) in an independent, objective and transparent manner, on the basis of all available scientific information and data. EFSA is implementing the systematic review (SR) method to inform risk assessment models. SRs adopt a methodologically rigorous stepwise process (to help to minimise biases), emphasising transparency and reproducibility.

To minimise bias SRs include an extensive literature search. Locating all relevant information sources can be problematic and missing relevant scientific information may influence SR conclusions. This Technical Manual provides guidance for performing electronic literature searches (ELS) to inform systematic reviews in EFSA risk assessments (Deliverable 4). Where possible the manual is supported by evidence from the literature of food and feed safety information retrieval.

The manual describes the context of literature searching for systematic reviews, how to construct search strategies and which information sources to search including how to access the grey literature and how to assess new information sources for relevance. The manual also covers peer review of search strategies, how to manage references using EndNote and how to document the search process and report the searches. The manual also provides information on building research into literature searching projects to improve the evidence base for information retrieval in food and feed safety.

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### KEY WORDS

Literature searching; Systematic reviews; Information sources; Databases; Search strategies

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## SUMMARY

Regulation (EC) No 178/2002 recommends that risk assessments are undertaken by the European Food Safety Authority (EFSA) in an independent, objective and transparent manner, on the basis of all available scientific information and data. EFSA is implementing the systematic review (SR) method to inform risk assessment models. SRs adopt a methodologically rigorous stepwise process (to help to minimise biases), emphasising transparency and reproducibility.

To minimise bias SRs include an extensive literature search. Locating all relevant information sources can be problematic and missing relevant scientific information may influence SR conclusions. The EFSA Scientific Assessment Support Unit contracted YHEC (CFT/EFSA/SAS/2011/03) to produce five deliverables to support literature searching to inform SRs of food and feed safety.

This report forms a Technical Manual for performing electronic literature searches (ELS) to inform systematic reviews in EFSA risk assessments (Deliverable 4). The content supports and cross-references the EFSA guidance to systematic reviews (EFSA 2010) and will form the supporting material for the information training sessions delivered to EFSA by YHEC (Deliverable 5).

Most systematic review guidance, including the Cochrane Handbook, seeks to be evidence-based. Although the evidence base in food and feed safety information retrieval is sparse, we have undertaken literature searches to ensure that relevant evidence for information retrieval which is available is referenced within this report, and where recommendations are unsupported by the evidence, that this is clearly signposted. An EndNote library of papers reporting literature searching methods accompanies this report, so that, if desired, the evidence base can be updated in the future as new research is identified.

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## **BACKGROUND AS PROVIDED BY EFSA**

Regulation (EC) No 178/2002 recommends that risk assessments (RA) are undertaken by the European Food Safety Authority (EFSA) in an independent, objective and transparent manner, on the basis of all available scientific information and data.

EFSA has analysed the use of systematic reviews (SR) to retrieve, appraise and synthesise publicly available and accessible scientific evidence to produce evidence-based risk assessments and, where possible, is implementing the SR method to inform EFSA's risk assessment models. The systematic review is a stepwise process whose fundamental principles are methodological rigour (which helps to minimise biases in the review), transparency and reproducibility.

These principles apply to all steps of the SR process including the first, i.e. the extensive literature search (ELS), which must be:

- (a) Thorough and extensive, to ensure all studies relevant to the subject under review are located, reduce publication biases and reflect the variability across studies;
- (b) Well-documented, to promote transparency and allow reproducibility of the search process.

The essential aspects of an ELS are the tailored search strategy/s (especially for searches in electronic bibliographic databases) and the extensive list of information sources used (i.e. electronic bibliographic databases and other sources accessed *via* hand-searching such as e.g. websites, journals tables of content, theses, and repositories).

In a SR team the extensive literature searches are normally undertaken by the Information Specialist, who has specific knowledge of database features, and skills in capturing the concepts included in a review question in the search strategy. However, it is important that all reviewers commissioning and evaluating literature searches, as well as researchers new to the systematic review approach, have a clear understanding of the basics of search strategy development and hand-searching and are familiar with how searches are constructed and adapted to meet project needs.

When starting a SR in food and feed safety, locating all relevant information sources is not always easy and often there is the risk of overlooking relevant sources and consequently missing out relevant scientific information that may influence the conclusions of the final output. The need for a clear definition of the sources of scientific evidence relevant to an EFSA research topic has also recently been emphasised in the EFSA public Consultation on a draft Guidance on Submission of scientific peer-reviewed open literature for the approval of pesticide active substances. For these reasons, the EFSA Scientific Assessment Support Unit (referred to as SAS in this document) has carried out a preliminary exercise to identify and classify scientific information sources relevant to EFSA's risk assessment.

## **TERMS OF REFERENCE AS PROVIDED BY EFSA**

This contract/grant was awarded by EFSA to:

Contractor/Beneficiary: York Health Economics Consortium

Contract/grant title: Inventory of Sources of Scientific Evidence Relevant to EFSA's Risk

Assessments and Information Sessions on Literature Searching Techniques

Contract/grant number: CFT/EFSA/SAS/2011/03

## INTRODUCTION AND OBJECTIVES

The European Food Safety Agency (EFSA) has contracted YHEC (CFT/EFSA/SAS/2011/03) to deliver a series of deliverables to support literature searching to inform systematic reviews of food and feed safety:

1. A metadata schema;
2. An inventory of key data sources and evidence-based combinations of data sources;
3. A business analysis of IT tools (compatible with the EFSA IT environment) for presenting and searching the sources identified in deliverable 2;
4. A technical manual for performing electronic literature searches (ELS) to inform systematic reviews in EFSA risk assessments;
5. Six training sessions tailored for EFSA to train EFSA staff and experts in searching techniques to inform systematic reviews in food and feed safety risk assessment.

EFSA requested a Technical Manual which comprehensively describes search strategy development and the identification of relevant and reliable information sources. This Technical Manual describes:

- The context of literature searching to inform systematic reviews;
- How to identify relevant and reliable information sources;
- How to construct and run a sensitive search strategy;
- Practical issues such as how to record the search strategy and manage the search results;
- How to develop the evidence on best literature searching techniques in the field of food and feed safety.

## MATERIALS AND METHODS

### 1. The context of literature searching to inform systematic reviews

A systematic review is “an overview of existing evidence pertinent to a clearly formulated question, which uses pre-specified and standardised methods to identify and critically appraise relevant research, and to collect, report and analyse data from the studies that are included in the review.” (EFSA 2010)

The systematic review method consists of eight steps (EFSA 2010):

- Preparing a review;
- Searching for studies;
- Selecting relevant studies for inclusion;
- Collecting data from the included studies;

- Assessing the methodological quality of the included studies;
- Synthesising data from the included studies;
- Presenting the data and results;
- Interpreting the results and drawing conclusions.

The literature search is the second key stage of the systematic review method. The aim of the literature search in this context is to identify as many relevant studies as possible (within resource limits), and to do so in an objective, thorough and reproducible way (Lefebvre et al. 2011). The validity of the systematic review findings is directly related to the quality of the search and the reproducibility of the search protocol (Sargeant 2005). It is therefore essential that the review team members understand the key challenges faced when trying to identify relevant studies, and the methods used to manage these challenges. It is also essential that they understand the importance of accurate search documentation and reporting. This understanding will enable the systematic review search process to be planned for, resourced and carried out in the most efficient and effective way.

Literature searching has some concepts and terminology which may be unfamiliar: definitions of key concepts and terms are shown in Table 1.

**Table 1:** Glossary: key concepts in electronic literature searching

Concept/term	Definition
Controlled vocabulary	A prescribed, pre-defined list of terms or headings, each one having an assigned meaning. In information retrieval, terms from a controlled vocabulary can be used to “tag” records in information sources in order to aid retrieval. Controlled vocabularies reduce ambiguity inherent in natural language where the same concept can be given different names, or the same term can have multiple meanings.
Free text terms	Free-text terms (also called text words) are used by authors in the title and abstract of studies; these terms are then searchable in the title and abstract of electronic records in information sources.
(Key) element	A concept which forms part of the research question, for example the Population or the Exposure, and which can form part of a search strategy. For further information see the EFSA guidance (EFSA 2010).
Indexing language	A controlled vocabulary used to index records in an information source to enhance consistent retrieval of records. The indexing language may also be known as an information source’s thesaurus.
Indexing term	A word from a controlled vocabulary, indexing language or information source’s thesaurus.
Information source	A database, website or library which provides access to research evidence and other documents.
Precision	The proportion of relevant records among all the records retrieved by a search strategy (number of relevant records retrieved/total number of records retrieved).
Proximity operators	These are search commands which indicate that search terms can be retrieved within a certain distance from another search term. The distance may be a certain number of words, or within a sentence or a paragraph.
Search filters	A collection of search terms (words in the title, abstract or indexing of information source records) which identify records about a specific population, study design or other concept; ideally derived by research.
Search strategy	A collection of search terms (words in the title, abstract or indexing of information source records) combined together and used to interrogate an

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Sensitivity	information source to identify relevant records. The proportion of relevant records retrieved by a search strategy (number of relevant records retrieved/total number of relevant records in existence)
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## 1.1. Key challenges

There are two key challenges to identifying relevant studies of which the searcher must be aware and which the search strategy must aim to minimise. Firstly, reporting biases and secondly the limitations of research records and indexing in information sources.

### 1.1.1. Publication biases

Evidence from the biomedical literature field indicates that the accessibility of research is impacted by a number of publication biases. Research has found that "statistically significant, 'positive' results that indicate that an intervention works are more likely to be published, more likely to be published rapidly, more likely to be published in English, more likely to be published more than once, more likely to be published in high impact journals and, related to the last point, more likely to be cited by others" (Sterne et al. 2011). These biases pose a significant challenge for the search aiming to retrieve all relevant studies. As a result of publication bias, a significant proportion of research will not be published in peer-reviewed journals. Of the research which is published, a significant proportion will not be indexed in the major bibliographic databases (Sterne et al. 2011). The evidence cited relates to the human health field and less research has been carried out in relation to the food and feed safety literature. However, there is some evidence to suggest that publication bias is also an issue in this field (EFSA 2010, O'Brien et al. 2006, Snedeker 2010). Although the nature and extent of publication bias across all of the fields of relevance to food and feed safety is currently unknown, reviewers should assume that the food and feed safety literature is subject to the same biases as the biomedical research. Search strategies should always seek to minimise the effects of this bias by including searches beyond the peer-reviewed journal literature, whilst reviewers should be aware that identifying unpublished studies can be time and resource intensive with no guarantees of success.

### 1.1.2. Limitations of information sources

The limitations of research records and indexing available in information sources mean that even when a study is recorded in an information source, a specific search strategy may not find it (Lefebvre et al. 2011, Kassai 2006). Just because a record exists in a bibliographic database does not mean it is straightforward to find, even when using 'appropriate' search strategies that search across indexing and free text (title and abstract) fields. There can be a number of reasons for this. For example, the application of indexing terms to references in information sources is largely carried out by humans and so is subjective and open to error; research may not be indexed in the way which seems most obvious or the way that we anticipate. There may also be significant variation used by the authors to describe the same key elements in the title and abstract of information source records. Abstracts in databases are brief (or may not exist) and may not capture all aspects of a full document because of the limits of space. Authors may not describe their methods or other elements of their research clearly in the abstracts; particularly the outcomes which are often described only in the full text of the paper. These issues pose a significant challenge for the search aiming to retrieve all relevant studies, and the searcher must anticipate and seek to minimise their potential impact.

## 1.2. The importance of extensive searching

In order to minimise the impact of publication bias and limitations in indexing, and retrieve as much of the relevant evidence as possible, literature searches to inform systematic reviews should be extensive. They should search a range of information sources and adopt a sensitive (see Table 1) approach to the search terms selected.

The searching of multiple information sources increases the likelihood of retrieving records which are not found elsewhere (Avenell et al. 2001, Grindlay et al. 2012). It also reduces the impact of variability of indexing within information sources; a study which is not retrieved by a search strategy in one information source may be retrieved by a similar search strategy used in another information source (Lefebvre et al. 2011). Searchers should consider the topic of their review question when identifying information sources to search. In contexts such as agri-food related health research, for example, these may include both medical and agriculturally oriented information sources (Sargeant et al. 2006). The selection of information resources should aim to enable identification of both published research and unpublished research (unpublished research includes what is often described as grey literature<sup>1</sup>) in order to reduce the impact of publication bias. Where possible, the selection of information sources should also facilitate retrieval of research published in languages other than English, and on-going and recently completed research. In addition to bibliographic database and research register searching, additional techniques can be considered. These may include, for example, the use of citation indexes, web-searching and hand-searching (Lefebvre et al. 2011). Section 2 of this manual focuses in detail on the selection of information sources.

## 1.3. The importance of constructing sensitive search strategies

In order to retrieve as many studies relevant to the review as possible, and to compensate for the limitations of information source records and indexing, search strategy development and construction should aim for sensitivity (see Table 1) (Centre for Reviews and Dissemination 2009; EFSA 2010; Lefebvre et al. 2011). Search strategy techniques and information source functionality within the available interfaces should be exploited to achieve this, for example through the range of search terms used and the use of truncation, proximity operators and controlled vocabulary (Lefebvre et al. 2011). Inevitably there is a trade-off in terms of reduced precision (Table 1) when conducting sensitive searches. Increasing the sensitivity of a search increases the possibility of identifying all relevant studies within that information source, but also tends to reduce precision because the number of irrelevant results is increased (Centre for Reviews and Dissemination 2009; Lefebvre et al. 2011). The number of results retrieved, and which therefore must be assessed for relevance to the review question, has implications for the resources required to conduct a systematic review. This trade-off between sensitivity and precision should therefore be acknowledged as part of the systematic review search process, and an appropriate balance sought within the context of the resources available. Section 3 of this manual focuses in detail on constructing appropriate search strategies for systematic reviews in food and feed safety.

## 1.4. The importance of documenting and recording searches

The systematic review method aims to reduce the impact of bias, and the review processes should be transparent and reproducible (EFSA 2010). It is essential that the search strategy, as part of this method, is recorded in enough detail to facilitate appropriate assessment of its quality and to enable replication (Centre for Reviews and Dissemination 2009; EFSA 2010; Lefebvre et al. 2011). As there is evidence that the reporting of searches in reviews is less than optimal in biomedical, animal health

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<sup>1</sup> The Interagency Gray Literature Working group defines grey literature as “open source material that is usually available through specialised channels and may not enter normal channels of systems of publication, distribution, bibliographical control or subscription agents”

and food safety disciplines, appropriate attention should be given to this step so that the quality of the review is not undermined (Sargeant et al. 2006b, Waddell 2009). In order to enable full assessment of the validity of the review and its findings, searchers must ensure that the search process is documented and reported in full. Section 4 of this manual focuses on practical issues of systematic review searching, including documenting the search process during the search, and reporting the search in the final report.

### 1.5. The role of the information specialist

The EFSA (2010) Guidance on systematic review methodology states that:

*“the review team should include expertise in the relevant topic area, information retrieval, statistics, and systematic review methods. The role of the information specialist is fundamental to develop appropriate search strategies, identify appropriate and relevant information sources and guarantee the extensiveness of the information retrieved.”*

An appropriate literature search, structured to identify and retrieve as many relevant studies as possible, is a key component of a successful systematic review. The validity of the review findings is directly related to the quality of the search and the sensitivity and reproducibility of the search protocol (Sargeant et al. 2005). It is therefore recommended that all systematic reviews involve an experienced information specialist who can provide the appropriate level of expertise (Sargeant et al. 2005; EFSA 2010; Lefebvre et al. 2011). An experienced information specialist should possess expert knowledge of different information sources and search interfaces, methods of developing and constructing search strategies, how to translate search strategies for different sources, the use of additional search techniques, and best reference management and documentation practice.

### 1.6. Evidence-based information retrieval

Extensive literature searches for systematic reviews should be based as far as possible on the best practices in effective and efficient information retrieval (i.e. based on what research evidence tells us are the best ways to search and the best information sources to search). Although a relatively large amount of information retrieval research has been conducted in the biomedical field on questions relating to search techniques and information sources, the evidence base for information retrieval practices in food and feed safety is sparse and is likely to benefit from an investment in methods research. Section 5 of this manual focuses on building information retrieval research into the systematic review process, provides guidance on aspects of the information retrieval process which can be informed by research and suggests some standard approaches to conducting research projects during or after a systematic review.

## 2. Constructing search strategies

It has been difficult to find examples of high-quality, sensitive search strategies in the food and feed safety literature. Waddell's (2009) investigation of methodological quality in zoonotic public health reviews found that only two of 132 papers assessed described the methods used to identify their included studies. A similar study conducted in the food safety literature found that none of 65 review articles that were evaluated explicitly described their search strategy (Sargeant et al. 2006). The majority of the evidence on constructing a search strategy is therefore taken from the health literature where the evidence-base is well-developed. The sections below consider the access points within database records for which search strategies must be designed and then discusses how to construct search strategies to answer review questions.

### 2.1. How can information source records be searched?

Large bibliographic databases usually contain records providing summary information about an item; one database can contain millions of individual records. These records offer access points which can take the form of words, phrases or codes. The terms and codes used in the search strategy must match the access points in the record or it will not be found. Figure 1 shows a simplified MEDLINE record illustrating some of the access points or fields that it is possible to search in a specific interface: the Ovid interface. The left hand column of Figure 1 shows the fields in the record which can typically be used as access points. The most used access points are usually the title and abstract (known as free-text terms) and subject indexing terms (described in Section 2.2).

The search strategy can specify that the interface interrogating the information source should only look for the search terms in a specific part of the record. Doing so can have a significant impact on the results that are retrieved as demonstrated in Table 2.

### 2.2. Subject indexing

Subject indexing provides a way to search information sources using a controlled vocabulary. Indexing terms from a controlled vocabulary, or thesaurus, are assigned to records, usually by a human indexer, to describe the content of the item. Subject indexing terms are valuable in increasing the sensitivity of a search as they provide a way of retrieving records which may use different words to describe a key element (Table 1) of the review question in the title and abstract. They can also provide information which is beyond that contained in the title and abstract. An author may not make the study methodology clear in the title and abstract, but the indexing terms can be used to identify the full text item as a randomized controlled trial report or a case report.

Many information sources use their own subject indexing schemes or thesauri. Medical Subject Headings (MeSH) is the name of the subject indexing used in MEDLINE; Embase uses a scheme called Emtree and other databases use other schemes. These indexing schemes are not interchangeable; the index term used to describe a concept in one information source is often different to that used in another information source. The search strategy must be adapted to reflect these differences as it is transferred across information sources.

Searchers should be aware that controlled vocabularies have evolved over time, with index terms being added and removed to reflect developments in the discipline covered by the indexing scheme. This can impact on the design of the search strategy. For example, few MeSH index terms related to study design were available pre-1990 and therefore the index terms must be supplemented with relevant free-text terms (searching the title and abstract) to retrieve this older material (Lefebvre 2011).

If an information source uses a well-developed controlled vocabulary then the subject indexing is likely to be organised in a hierarchy. Broader, more general, index terms can have more specific terms nested underneath them (Figure 2).

**Figure 1:** simplified MEDLINE record

Fields/record access points	Example
Authors	Knap, I. Kehlet, A B. Bennedsen, M. Mathis, G F. Hofacre, C L. Lumpkins, B S. Jensen, M M. Raun, M. Lay, A.
Institution	Chr. Hansen A/S, Boege Alle 10-12, 2970 Hoersholm, Denmark.
Title (free-text)	Bacillus subtilis (DSM17299) significantly reduces Salmonella in broilers.
Source	Poultry Science. 90(8):1690-4, 2011 Aug.
NLM journal name	Poultry science
Country of publication	United States
Medical Subject headings (MeSH)	Animal Feed; Animals; *Bacillus subtilis / cl [Classification]; *Bacillus subtilis / ph [Physiology]; Cecum / mi [Microbiology]; *Chickens; Diet / ve [Veterinary]; Feces / mi [Microbiology]; Food Microbiology; Gastrointestinal Contents / mi [Microbiology]; *Poultry Diseases / mi [Microbiology]; Poultry Diseases / pc [Prevention & Control]; Probiotics / pd [Pharmacology]; *Salmonella / ph [Physiology]; *Salmonella Infections, Animal / mi [Microbiology]; Salmonella Infections, Animal / pc [Prevention & Control]
Abstract (free-text)	Salmonella continues to be a major public health burden worldwide. Poultry are known to be one of the main reservoirs for this zoonotic pathogen. It has previously been shown that a single dose of Bacillus subtilis reduces fecal shedding of Salmonella enterica serovar Enteritidis, whereas no effect on long-term colonization of the cecum has been observed. Here we report experiments that were undertaken to test the efficacy of a conventional diet supplemented with a probiotic (B. subtilisDSM17299) on 1) Salmonella colonization in the intestinal tract of broiler chickens, and 2) fecal shedding of Salmonella under production-like conditions. The trial birds fed the B. subtilis diet showed a significant 58% reduction in Salmonella-positive drag swabs compared with control birds, which had 100% presence of Salmonella. Feeding B. subtilis significantly reduced the average Salmonella load of cecum samples of the chickens, by 3 log units. This reduction in Salmonella colonization might not only positively affect broilers on the live production side by reducing the risk of infection between birds, but could also aid on the processing side by decreasing the amount of Salmonella entering the facility and improving food safety. Furthermore, numerical, but not statistically significant, improvements in feed conversion rate and BW gain at d 42 were observed in the B. subtilis-treated group compared with control birds.
Publication type	Controlled Clinical Trial. Journal Article.
Language	English
Year of publication	2011

**Table 2:** The impact of searching different fields in a MEDLINE record in the Ovid interface

Search strategy (Ovid interface)	Fields searched	Number of results returned in Ovid MEDLINE
probiotics	Ovid defaults to a search which is shown in the output as probiotics.mp. As standard, this means that Ovid has searched the title, abstract, original title, names of substance word, subject heading word, protocol supplementary concept, rare disease supplementary concept and unique identifier fields. It is possible to manually alter which fields are searched in Ovid by using field limits, as shown in the following lines (i.e. probiotics.ti. just searches the title field.	8565
probiotics.ti	Searches the Title field only	1935
probiotics.ti.ab.	Searches the Title and abstract fields	4645
probiotics.in.	Searches the Institution field	75
probiotics.rn.	Searches the Registry number field	0
Probiotics/	Searches the subject indexing field	7230
probiotics.ti.ab. AND randomized controlled trial.pt	Probiotics is searched in either the title or abstract fields and the results are combined to with a search in the publication type (.pt.) field.	433

**Figure 2:** The MEDLINE subject indexing (MeSH) tree for the index term “Salmonella”

### Salmonella

Salmonella arizonae

Salmonella enterica

Salmonella enteritidis

Salmonella paratyphi A

Salmonella paratyphi B

Salmonella paratyphi C

Salmonella typhi

Salmonella typhimurium

An indexer will generally have applied to the record the most specific subject heading available. If the publication being indexed is about *Salmonella enteritidis* the indexer will have applied that heading, rather than the more general index term “Salmonella”. Some databases offer an explode feature whereby entering the more general index term “Salmonella” also retrieves the more specific terms in the hierarchy, thus saving time.

Indexing terms alone are not enough when searching for studies for a systematic review and searchers should assess the suitability of the indexing available for the specific topic. Searching indexing terms alone will miss new and unindexed records where they are included in an information source. For

example, PubMed and MEDLINE In-Process contain records which are yet to be indexed and so can only be retrieved with free text search terms. It should be noted that the accuracy of indexing can be affected by an author who reports study methods and objectives poorly, or by an indexer who fails to notice the methods reported in the publication. Subject indexing can also fail to capture the topic of interest at the level of granularity required: papers on male breast cancer for example may be indexed under a heading which includes male and female breast cancer. Additionally, care should be taken when searching in topic areas which do not use the precisely defined vocabularies found in disciplines like medicine and veterinary science. Where subject indexing is inadequate, for whatever reason, searchers will be aware that they are relying much more on the free-text terms in the strategy, and that using the subject indexing terms may impact on precision.

### 2.2.1. Subheadings

Subheadings are used by some subject indexing schemes such as MeSH and Emtree and can be added to a subject indexing term in order to focus it. For example, in Ovid MEDLINE the search construction 'Probiotics/ae' will restrict the probiotics subject indexing term to those records where the adverse effects of probiotics are addressed. Ae is the subheading which denotes adverse effects.

The subheadings can also be searched on their own, unattached to specific subject headings. In this context they are called floating subheadings. In Ovid MEDLINE, the search construction 'Probiotics/ and ae.fs.' will find records which are indexed with the term Probiotics, **and** also have adverse effects applied as a subheading to **any** of the indexing terms in the record. This is less precise than 'Probiotics/ae' but may increase the sensitivity of the search.

As with indexing terms, subheadings will have been applied to bibliographic records by a human indexer and are therefore not infallible. For this reason, it is suggested that when constructing a search strategy subheadings are not used as the sole approach to searching but as an additional search approach as shown in Figure 3.

**Figure 3:** The use of subheadings and other terms to identify adverse effects in MEDLINE

- 1 (Probiotics and adverse effects).ti,ab.
- 2 Probiotics/ae
- 3 1 or 2

### 2.3. Words in the title and abstract

The default search terms in any strategy are likely to be those used to search the title and abstract of a record, because there are some databases which do not have subject indexing schemes. When gathering search terms the use of search options offered by the information source interface such as truncation and proximity operators should be considered: these are described in more detail below (section 2.6). As well as the title and abstract other fields may also be considered for some questions:

- Journal name – the journal name can be searched in some information sources and may be a useful way to improve the sensitivity of the search strategy. For example, searching for the term 'poultry' in the journal name may enhance the sensitivity of a search focusing on diseases of poultry. This is because authors publishing in a journal devoted to poultry science may not feel they need to be as explicit in their abstract because the readership will take some of the content or focus as understood.

- Authors' affiliation – the name of the authors' organisation may also have potential for improving the sensitivity of the search strategy when the name of the organisation is indicative, e.g. poultry research centre.

#### 2.4. Identifying key elements

The review question should be broken down into its key elements in order to guide the development of search terms and the structure of the search (EFSA 2010). The EFSA Guidance recommends that a conceptual model such as PICO/PECO, PIT, or PO should be used to identify these key elements.

PICO/PECO (the key elements being population, intervention/exposure, comparator, outcomes) may be used when the review is designed to evaluate the effects of an intervention or exposure.

PIT (the key elements being population, index test, target condition) can be used for reviews of test accuracy.

PO (the key elements being population, outcome) may be used for reviews which aim to answer descriptive questions. This covers questions about prevalence, occurrence, consumption and incidence (EFSA 2010).

It is not necessary, nor is it often desirable, to include every key element in the search strategy. Only those key elements that can be clearly defined and translated into search terms should be included; some concepts are too difficult to search for sensitively. Some key elements, particularly the outcomes, may be excluded from consideration for inclusion in the search strategy because they are frequently not reported in the title or abstract of the bibliographic record. Furthermore, the fewer key elements used in the strategy, the more sensitive the search and the smaller the risk of missing a relevant record.

Key elements which are not captured in the search strategy will still be required at the record selection stage in order to select records most likely to meet the eligibility criteria of the systematic review.

As an example, a review question on probiotic feed supplementation for the prevention of *Salmonella* infection in poultry can be broken down into four key elements (Table 3).

**Table 3:** PICO worked example: probiotic feed supplementation for the prevention of *Salmonella* infection in poultry.

Key element	Specific elements for this systematic review
Population	Poultry
Intervention	Probiotics
Comparator	No probiotics
Outcomes	<i>Salmonella</i> prevention

The comparator (no probiotics) would not be included in the search strategy. This key element will be difficult to express using free-text or index terms and may not be explicitly described in the title or abstract. It is possible to explore the use of additional key element when developing a search strategy; by comparing the results with and without an additional key element the searcher can assess the volume of records retrieved by each strategy. Looking at the records lost by searching with an additional element can also determine whether those records are potentially relevant (pointing to a

strategy without additional key elements) or not relevant (pointing to the use of additional key elements).

## 2.5. Identifying search terms

As described in Section 1, to design a sensitive search strategy searchers should employ a combination of indexing terms (selected from the indexing language or thesaurus) and a wide range of free-text (title and abstract) terms.

When choosing free-text terms to use in a search strategy the reviewer should consider as many synonyms and related terms as possible. This is necessary to compensate for the fact that similar research is often described using very different language, and that the information available to be searched can be very limited. It is important to consider:

- Differences in UK and US spelling and terminology;
- Abbreviated and non-abbreviated terms;
- Differences in word ending (e.g. account for singular and plural, past and present tense, active and passive verb forms);
- Both the generic and branded names of products such as pharmaceuticals and pesticides;
- Changes in vocabulary over time (e.g. third world country, developing country, low-income country).

Table 4 shows how free-text terms are typically built up into a listing by key element.

For each of the free-text terms that are chosen, a searcher should attempt to identify any corresponding indexing terms used in any information sources which will be searched. The search tools provided within the information source can assist with this. For example, the “Map term to subject heading” function in the Ovid interface can be used to identify relevant indexing terms for the free-text terms that are provided by a searcher.

Further free text and subject indexing terms can be identified by:

- Checking the terms used in bibliographic records of key papers identified by initial broad searches (sometimes referred to as snowballing or pearl growing<sup>2</sup>);
- Scanning bibliographies at the end of systematic reviews or key papers;
- Consulting topic experts;
- Scanning database subject indexing guides.

Many database thesauri offer the facility to ‘explode’ indexing terms to automatically include any more specific terms in the search (see Section 2.2). In MeSH, the broader index term ‘Poultry’ can be exploded to also find papers indexed with the more specific terms ‘Chickens’, ‘Ducks’, ‘Geese’ and ‘Turkeys’ which appear underneath it in the hierarchy. If these narrower terms are relevant to the search topic then explosion (if available) can be a time saving feature. Table 5 shows examples of

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<sup>2</sup> <http://hlwiki.slais.ubc.ca/index.php/Snowballing> Last accessed: 11 Oct 2012

subject indexing terms (MeSH) for the key elements of interest in the worked example of on probiotic feed supplementation for the prevention of *Salmonella* infection in poultry.

**Table 4:** Examples of free-text search terms for a systematic review on probiotic feed supplementation for the prevention of *Salmonella* infection in poultry.

Poultry	Probiotics	<i>Salmonella</i>
Poultry	Probiotic(s)	Salmonella
Fowl	Lactobacillaceae	Salmonellosis
Broiler(s)	Lactobacillus	Salmonella Enteritis
Chicken(s)	Lactobacilli	Enteritis Salmonella
Chick(s)	Lactic acid bacteria	Salmonella enterica subsp. enterica
Turkey(s)	Bifidobacteria	
Duck(s)	Bifidobacterium	
Goose	Bifidus	
Geese	Pediococcus	
Pigeon(s)	Lactococcus	
Guineafowl	Saccharomyces	
Pheasant(s)	Bacillus subtilis	
Flock(s)		

**Table 5:** Examples of indexing terms [MeSH, used by MEDLINE] for a systematic review on probiotic feed supplementation for the prevention of *Salmonella* infection in poultry

Poultry	Probiotics	<i>Salmonella</i>
exp Poultry	Probiotics exp Bifidobacterium exp Lactobacillaceae Lactococcus Saccharomyces Bacillus subtilis	exp Salmonella Salmonella Infections, Animals

Key: exp shows that this index term has been “exploded”, meaning that it includes narrower, related headings.

## 2.6. Constructing a search strategy

### 2.6.1. Boolean operators

Boolean operators (AND, OR, NOT) are used by many information sources to combine search terms (both free-text and index terms) together into a strategy.

The OR operator will find records containing one or more of the search terms; using OR makes the search larger. It should be used to join search terms for the same key element. One set of terms, combined with OR, should be developed for each key element. For example with poultry as the Population key element the various free-text and subject heading terms can be combined together using OR:

1. poultry OR fowl<sup>3</sup> OR chicken\$ OR turkey\$ OR broiler\$ OR duck\$ OR goose OR geese
2. exp Poultry/<sup>4</sup>
3. 1 OR 2

<sup>3</sup> \$ denotes truncation which is explained further in section 2.6.2

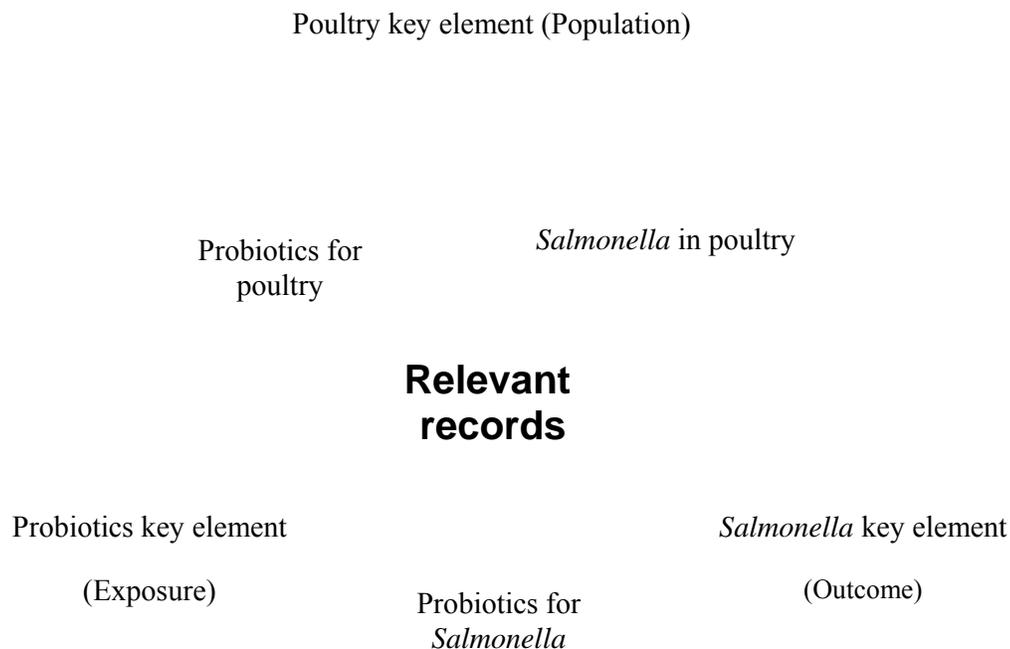
<sup>4</sup> / denotes a subject heading search in Ovid MEDLINE, exp denotes that the subject heading has been exploded to capture more specific terms.

The AND operator will find records that each contain all of the search terms; using AND makes the search narrower or more focused. It should be used to join two (or more) key elements together. For example the Population key element terms for poultry (search line 3) can be combined with the *Salmonella* Outcome key element terms (search line 6) using AND in search line 7:

1. poultry OR fowl\$ OR chicken\$ OR turkey\$ OR broiler\$ OR duck\$ OR goose OR geese
2. exp Poultry/
3. 1 OR 2
4. Salmonell\$
5. Salmonella Infections, Animals/ OR exp Salmonella/
6. 4 OR 5
7. 3 AND 6

The records retrieved by search line 7 must contain at least one search term for each key element. Figure 4 shows a Venn diagram illustrating the Boolean operators used to combine three key elements: poultry, *salmonella* and probiotics.

**Figure 4:** Combining key elements as search sets



The NOT operator is used to exclude records from the search. However, it should be avoided where possible as it can have a significant impact on the sensitivity of the search by inadvertently removing relevant records. For example, searching for poultry NOT swine would remove any record that was about swine, irrespective of whether it also referred to poultry.

The following search functions can enhance the sensitivity or precision of the search when used with free text terms. These features vary across information sources; the help file for each source should be consulted for further guidance.

### 2.6.2. Truncation

Truncation can be used to specify different word endings. The truncation symbol is placed at the root of the word, and the information source will find any word beginning with that root. This reduces the number of free-text terms that must be typed. For example, lactobacill\$ will identify records containing the terms lactobacillaceae, lactobacillus or lactobacilli. As illustrated here, a dollar sign is commonly (but not always) used as the truncation character in a bibliographic database's search syntax. The asterisk is also frequently used by information sources to denote truncation.

Truncation with a short word stem (i.e. three letters or less) should be avoided: it may enhance sensitivity but may impact badly on precision, retrieving too many irrelevant records. For example, truncating 'lacto\$' would retrieve many irrelevant records about lactose intolerance as well as records about lactobacillus.

### 2.6.3. Wildcards

Wildcards are used to account for internal spelling variation and can be particularly useful when trying to capture differences in British and US spelling e.g. randomi?ed will identify records containing both randomized and randomised. As illustrated here, a question mark is commonly (but not always) used as the wildcard character in a bibliographic database's search syntax.

### 2.6.4. Proximity operators

Some interfaces to information sources allow a searcher to specify that free-text terms should appear adjacent to each other. In some interfaces it is additionally possible to specify that the terms should appear within a specific number of words of each other. This feature is especially useful when trying to account for very variable vocabulary. For example, bacteria\$ adj3 (load\$ or level\$ or log or logs or logging or logged or count\$) will search for bacteria or bacterial within three words of any of the terms in the set of brackets, in either direction. This search string would therefore identify a range of word groupings including 'bacterial load', 'levels of bacteria', 'bacteria counts', and 'logged numbers of bacteria'. Proximity operators offer better precision than the use of AND alone, since terms linked by AND may be widely separated within a record and semantically unrelated.

### 2.6.5. Worked example

The search strategy shown in Table 6 has been designed to retrieve studies from MEDLINE on probiotic feed supplementation for the prevention of *Salmonella* in poultry. It is specific to the Ovid interface in terms of the search syntax.

## 2.7. Limiting a search

Any limits applied to a search should be explicitly reported as part of the systematic review methodology. The decision to use limits (in all information sources or selected information sources) should usually be explained in a narrative report of the search strategy, as well as recorded in the

detailed list of search strategies. This is especially important if the limits are likely to have a significant impact on the retrieval of studies and potentially on the outcomes of the review.

Due to a lack of information about the impacts of limiting searches of food and feed safety literature, the following recommendations are made based on research findings from the human health field.

### 2.7.1. Date limits

Date restrictions should not be applied unless it is known that relevant studies could only have been reported with a certain time period (Lefebvre et al. 2011). This may be the case, for example, if the intervention or exposure was only introduced after a specific date.

### 2.7.2. Publication type or format limits

As studies are not always published in journal articles, it is often inappropriate to restrict the search in terms of publication format or type. For example, excluding letters may result in the loss of additional information relating to an earlier trial report or new information about a trial that has not been published elsewhere (Lefebvre et al. 2011).

**Table 6:** Worked example of a search strategy for the prevention of *salmonella* in poultry (Ovid MEDLINE)

	Commands	Explanation
<b>Search line</b>		
1	exp Poultry/	Explodes subject heading
2	(poultry or fowl or flock\$1).ti,ab.	Searches for words in title and abstract, 'flock' is truncated to find 0 or 1 additional characters
3	(chicken\$ or chick\$1 or broiler\$1).ti,ab.	Searches in the title and abstract
4	(turkey\$ or poult\$1 or turkeyling\$).ti,ab.	Searches in the title and abstract
5	(duck\$1 or goose or geese or pigeon\$ or guinea fowl or pheasant\$).ti,ab.	Searches in the title and abstract
6	or/1-6	Sets 1 to 6 are combined together using OR
7	Probiotics/	Search on subject heading, no explosion
8	exp Bifidobacterium/	Explodes subject heading
9	bifidobacteri\$.ti,ab.	Searches for words beginning bifidobacteri in the title and abstract
10	exp Lactobacilleceae/	Explodes subject heading
11	lactobacill\$.ti,ab.	Searches truncated term in title and abstract
12	Lactococcus/ or lactococcus.ti,ab.	Searches for subject heading and title and abstract terms
13	Saccharomyces/ or saccharomyces.ti,ab.	Searches for subject heading and title and abstract terms
14	Bacillus subtilis/ or bacillus subtilis.ti,ab.	Searches for subject heading and title and abstract terms
15	lactic acid bacteria.ti,ab.	Searches in the title and abstract
16	pediococcus.ti,ab.	Searches in the title and abstract
17	propionibacilli.ti,ab.	Searches in the title and abstract
18	bifidusbifido.ti,ab.	Searches in the title and abstract
19	strain adj3 mixture\$1.ti,ab.	Searches in the title and abstract using a proximity operator in case the terms are separated by other terms
20	or/7-19	Probiotics search results are combined together using OR

	Commands	Explanation
<b>Search line</b>		
21	exp Salmonella/ or Salmonella Infections, Animal/	<i>Salmonella</i> subject headings are searched for
22	salmonell\$.ti,ab.	Salmonell truncated is searched in title and abstract
23	bacteria\$ adj3 (load\$ or level\$ or count\$ or log or logs or logged or logging).ti,ab.	Bacteria is truncated and searched for where it occurs within 3 words of other terms including 'load'
24	or/21-23	Bacterial records are gathered together using OR
25	6 and 20 and 24	The three concepts are combined using AND

### 2.7.3. Language limits

Ideally, no language restrictions should be placed on the search strategy. Research in the health literature has investigated the effect of excluding trials reported in a language other than English from a meta-analysis. It has been found that bias can arise as researchers from non-English speaking countries are more likely to publish trials with positive results in English-language journals and trials with non-significant results in non-English language journals (Egger et al. 1997, Hopewell 2007).

Although time and budget restraints may not permit the inclusion of non-English language studies in the systematic review, the search should still aim to identify them. This will ensure their existence is documented and the reason for their exclusion (language) can be transparently reported in the review (Centre for Reviews and Dissemination 2009).

### 2.8. Search filters

Search filters are pre-tested, and sometimes validated, search strategies which are designed to retrieve specific types of study or topic (such as a specific population) from a named database. They usually consist of a set of indexing and free text terms which describe the study design or topic of interest. The filter is added to the search strategy designed to retrieve the review's key elements, in order to restrict the results to the required study design or topic of interest. The InterTASC Information Specialists' Sub-Group (ISSG) maintains the ISSG Search Filter Resource (<https://sites.google.com/a/york.ac.uk/issg-search-filters-resource/home>) which collates published and unpublished search filters grouped by study design and focus. An example of a search filter developed using research methods and validated against a gold standard of relevant records, the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in humans in MEDLINE, is shown in Figure 5 (Lefebvre et al. 2011).

**Figure 5:** Cochrane Highly Sensitive Search Strategy for identifying randomized trials in humans in MEDLINE: sensitivity maximizing version (2008 revision); Ovid format.

1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab.
5. drug therapy.fs.
6. randomly.ab.
7. trial.ab.
8. groups.ab.
9. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8

10. exp animals/ not humans/
  11. 9 not 10
- 

Key: .pt. searches the publication type field; .ab. searches the abstract; .fs. searches for floating subheadings; exp indicates an exploded subject heading; / indicates a subject heading

NOTE: line 10 illustrates the use of the NOT operator to identify animal studies which do not also relate humans: these records are then removed from the search in line 11.

The value and availability of search filters when conducting systematic reviews in food and feed safety are unknown (Murphy 2003). Published search filters have been developed primarily for use in large biomedical bibliographic databases such as MEDLINE. There has been little research into filters designed for use in the wider range of information sources required by reviewers searching the veterinary or agricultural literature. Moreover, whereas research has suggested that filters to retrieve RCTs in MEDLINE and Embase are reliable, evidence for the sensitivity and recall of filters for alternative study designs, more commonly used in food and feed safety research, is limited (Centre for Reviews and Dissemination 2009). Sargeant et al. (2006b) have reported that systematic reviews in agri-food public health require the identification of a much wider range of study designs, since RCTs are not widely used in this field.

Before incorporating any search filter into a search strategy, the author should assess the reliability of its development and reported performance. The current effectiveness of the filter should be considered given the frequent changes in interface and indexing terms affecting information sources (Lefebvre et al. 2011). The ISSG Search Filter Resource (<https://sites.google.com/a/york.ac.uk/issg-search-filters-resource/home>) provides guidance on critically appraising search filters and surveys of their performance which may aid this relevance and quality assessment process.

## **2.9. Transferring a search strategy to other information sources**

The search strategy is likely to be developed initially using one large, relevant, information source. It should be tested in that information source to ensure that it retrieves bibliographic records already known to the reviewers. At this stage the strategy may require refinements to ensure that any “missed” bibliographic records are found, or to add any additional free text or indexing terms identified in bibliographic records retrieved during the testing process. Peer review of the strategy by an experienced colleague can also help to develop the search strategy structure, eliminate errors in spelling, syntax or other aspects of the search.

Once the search strategy is finalised for the first information source it must then be adapted for use in other information sources. Here, care should be taken to preserve the sensitivity of the search. Free-text terms can usually be transferred without requiring any changes. However, any indexing terms must be changed to reflect the unique indexing languages used by each database. In MEDLINE the MeSH term for probiotics is “Probiotics”; if the search strategy was to be used in Embase then this would have to be substituted with the Emtree term “Probiotic Agents”.

Changes to the search strategy may also be required to reflect the different syntax used by different interfaces to information sources. Symbols used to denote truncation, wildcards and proximity operators can vary, as does the format for inputting Boolean operators and methods of combining sets.

Where an interface has very limited search functionality, a pragmatic approach should be taken. For example, a large search involving the combination of several key elements and many search terms within key elements may need to be broken down into several separate searches if options for combining key elements and/or many search terms are restricted.

### 3. Information sources

The objective when selecting information sources to search, is to identify those sources likely to yield relevant studies. An extensive search, using an appropriate range of information sources, will minimise the impact of publication bias on the systematic review and will help to address limitations in research reporting and indexing.

As the number of information sources searched is increased, so does the number of records and studies retrieved, albeit usually with diminishing returns. However, the aim of the search in a systematic review context is to identify as much relevant literature as possible and each information source may offer some unique content. For example, Elsevier note that over 25% of the journals indexed by Embase are not indexed in MEDLINE<sup>5</sup>. Therefore multiple information sources should always be searched. The sections below describe how to select information sources, the types of information to be identified and additional study identification techniques. A worked example is also provided, showing which information sources might be searched for a specific review question. The EFSA Inventory should be used for detailed listings and descriptions of relevant information sources in food and feed safety.

#### 3.1. Selecting information sources to search

There is no agreed acceptable number of information sources which should be searched to inform a systematic review; this is dependent on the focus of the review question and the resources available to the review team. A systematic review on the efficacy of a nutritional supplement in humans would require a search using information sources that specialise in indexing medical literature. However, a systematic review on an agri-public health topic such as the prevention of *Salmonella* in poultry would require the use of a wider range of information sources. The reviewer would potentially need to retrieve studies from a number of academic disciplines including medicine, agriculture and veterinary science (Sargeant et al. 2005).

Time and budget restraints will require the reviewers to balance the extensiveness and thoroughness of the search with an efficient use of resources. Key criteria which can be used to guide the selection of information sources are shown in Table 7.

**Table 7:** Information source selection checklist

Assessment criterion	Explanation
Does the information source contain publications of relevance to the review question?	Information sources focusing on research areas outside of the systematic review topic would be unlikely to contribute to the systematic review.
Does the information source contain a collection of searchable bibliographic data records or full text reports of research?	Large structured multidisciplinary or subject specific bibliographic databases are potentially the richest and most efficient to search.
Does the information source offer access to non-journal literature or records of on-going research?	Information sources which index grey literature offer opportunities for the search to include documents which can reduce publication bias.
Is the information source up to date?	Prioritisation for selection might be given to information sources which contain up to date information and which are regularly updated. Closed information sources might be of interest but would be viewed as lower priority than information sources

<sup>5</sup> <http://www.Embase.com/info/what-Embase>. Last accessed: 14Aug 2013. See also Suarez-Almazor et al. 2000 for a comparison in coverage between MEDLINE and Embase.

Assessment criterion	Explanation
Is the information source accessible to the systematic review team	<p>which are actively adding new records.</p> <p>Private in-house databases within organisations such as manufacturers' in-house databases may not be accessible. Other databases may be subscription only and if resources are lacking, it may not be possible to search them.</p>

### 3.2. Types of information sources

A checklist which can be used when considering which types of information sources to use for identifying studies for a review is shown in Table 8. Each method is described in further detail below.

**Table 8:** Checklist of information types and information sources for identifying studies

Type of information source	Details	Examples
Journal articles	Identify the bibliographic databases most likely to contain journals containing relevant studies. Consider sources with very specific subject coverage as well as those with multidisciplinary coverage.	CAB Abstracts (very large multidisciplinary database recording journal publications) Food science and technology abstracts (large subject specific database recording journal publications).
Books (monographs)	Books tend to be well recorded in national library catalogues	Library of Congress (multidisciplinary and international) British Library (multidisciplinary and international) Informit Health Collection (Australian health publications)
Dissertations and theses	If relevant, up-to-date information is likely to have been published in the form of a thesis or dissertation then searching these collections may be valuable.	ProQuest Dissertations and Theses (international and multidisciplinary) IndCat (index to Indian theses)
Conference proceedings	Conference proceedings offer access to ongoing and recently completed research which may not yet have been published in journals.	Conference Papers Index (multidisciplinary database) Specific: conference websites for disciplines relevant to the review question Web portals and internet search engines (e.g. ScientificWebPlus) are likely to search conferences
Reports and other grey literature	Reports, working papers and other non-journal publications can contain research evidence and may never be published in the journal literature. There is no central repository or major bibliographic source collecting reports, so searching for this type of literature involves searching a range of databases and websites.	NTIS (multidisciplinary) JSTOR (multidisciplinary) Specific: websites of research organisations and funders in disciplines relevant to the review question Web portals and internet search engines (e.g. ScientificWebPlus) are likely to search conferences
Scientific trials	Increasingly scientific and in particular clinical trials are registered prospectively. Registers may be available covering specific topics, type of study, funder and/or geographic area.	ClinicalTrials.gov (international clinical trials register) Specific: Manufacturers relevant to the review question and subject specific registers relevant to the review question (e.g. <a href="http://www.cancer.gov/clinicaltrials">http://www.cancer.gov/clinicaltrials</a> )

### 3.2.1. Journal articles

Bibliographic databases are the most efficient way to identify an initial set of relevant studies published as journal articles. They are usually designed to facilitate effective information retrieval with information presented in structured ways and often with the addition of indexing. Usually they can be searched using both free text and indexing terms. Most electronic bibliographic databases include abstracts for the majority of recent records and may include links to the full text of the article where available.

The coverage of various databases containing food and feed safety literature has been studied, although much of this research on database coverage originates from the field of health. MEDLINE, Embase and CENTRAL are generally considered to be the most important sources to search for reports of clinical trials (Lefebvre et al. 2011).

A simple, pragmatic method to identify useful information sources is to look at the volume of relevant journal titles indexed by individual information sources. This method has been used by researchers in the field of food and feed safety and has provided evidence for the value of CAB Abstracts. In the field of veterinary medicine, a 2012 study identified CAB Abstracts as an essential source to identify studies on this topic because of its coverage of relevant journals (Grindlay et al. 2012). CAB Abstracts indexed over 90 per cent of the veterinary journals identified by the authors; this was significantly more than any of the other databases studied either alone or in combination. Kawasaki has assessed information sources for their coverage of agriculture literature (Kawasaki 2004) and again identified CAB Abstracts as the best information source; indexing 92 per cent of the primary agriculture journals included in the study. These studies suggest that CAB Abstracts should be used for systematic review searches in veterinary medicine and agriculture.

Searches of databases with broader, more general coverage may need to be supplemented with information sources offering a specific focus on one of the key elements of the research question. Databases may cover a particular topic (e.g. AGRIS, agricultural science and technology), literature published in a specific geographic region (e.g. LILACS, medical journals from the Latin American and Caribbean region), or a particular type of information (WHOLIS, World Health Organization publications).

Searching bibliographic databases alone is unlikely to result in a sensitive search. Research findings published in reports, working papers, and conference proceedings are not routinely indexed in databases which focus on the journal literature. Such information sources will also fail to identify unpublished and on-going research, increasing the risk that publication bias will affect the conclusions of the review. Although much of the research into publication bias has been conducted in the health literature, there is some evidence the issue is also present in veterinary and agricultural research (Moles 2003, Berteaux et al. 2007). A range of other information sources and search techniques is usually required to identify additional relevant literature.

### 3.2.2. Books (monographs)

Books are the best-recorded publication format and can be identified by searching library catalogues. Large national libraries, such as the US Library of Congress and the British Library, provide excellent access to their international multidisciplinary collections and monographs can also be retrieved through internet search engines.

### 3.2.3. Dissertations and theses

Dissertations and theses tend to be recorded and indexed in specialised information sources (e.g. ProQuest's Dissertations & Theses Database) focused on this publication type and designed to promote access to these otherwise difficult to access documents by providing searchable records and options to order copies. In addition to these large multinational information sources, there is a wide range of national dissertation databases (e.g. Index to Theses in Great Britain and Ireland), some of which are included in the EFSA inventory. Many higher education institutions are also making their research outputs, including dissertations and theses, available via open access institutional repositories (e.g. <http://eprints.whiterose.ac.uk/>).

### 3.2.4. Conference proceedings

Studies in the human health literature have concluded that fifty per cent of trials reported in conference abstracts never reach full publication (Scherer 2007). Snedeker and colleagues have reported that only 45.6% of conference abstracts in a sample of studies about foodborne pathogens were published in peer-reviewed journals after four years (Snedeker 2010). Therefore, in order to minimize publication bias, it is important that relevant studies reported in conference abstracts are identified. It may then be possible to trace later publications or to contact the study authors for further information.

Although conference proceedings are not routinely indexed in journal databases, they can be searched via specific indexes such as the BIOSIS Citation Index and the Conference Proceedings Citation Index. However, such databases are unlikely to retrieve all relevant studies presented at conferences. A relative recall study undertaken by York Health Economics Consortium showed that that majority of conference papers included in a reference gold standard were not found in the Conference Proceedings Citation Index (Glanville et al. 2012). Hand-searching or electronically searching conference proceedings that are made available online, in print, or on CD-ROM is therefore recommended in addition to specialist database searches. The increasing trend for conferences to provide their abstracts on the conference or related website will improve access to this type of publication. However, conference websites are often transitory and there is a need for greater bibliographic control of conference publications. It is recommended that, during a systematic review, software snapshots are taken of any relevant conference abstracts or whole proceeding, to preserve a record of information which may be removed without warning.

### 3.2.5. Reports and other grey literature

Reports, working papers and publications from academic, professional and business organisations can contain research evidence and may never be published as journal articles. There is no central repository or major bibliographic source collecting reports, so searching for this type of literature involves searching a range of databases and websites. Information sources range from large national report databases such as the US NTIS service, to multinational grey literature repositories such as OpenGrey and internet search engines such as the US Department of Energy Office of Scientific and Technical Information (OSTI) WorldWideScience service. The challenge with report literature is that it is difficult to know how many relevant documents may have been missed. Experts may be useful in providing clues to the existence of reports (see Section 3.3.4).

### 3.2.6. Research registers

Research registers, including registers of clinical trials, are particularly useful for identifying on-going or unpublished scientific studies, which in turn provide means to reduce publication bias. There are a number of such registers and most are publically available on the internet. They may be disease specific (e.g. the National Cancer Institute Trial Registry), collect together trials from a particular country or region (e.g. the UK Clinical Trials Gateway), collect trials funded by a particular

organisation, or may be produced and maintained by pharmaceutical companies (e.g. IFPMA Clinical Trials Portals). In an effort to provide a single access point to on-going clinical trials the World Health Organisation has launched the International Clinical Trials Registry Platform Search Portal which searches across a range of international clinical trials registers.

### 3.3. Other search approaches

As well as searching information sources to identify research evidence, a range of other search approaches are often employed in systematic reviews, to identify additional publications or clues to the potential existence of publications (Table 9).

**Table 9:** Other search approaches used to identify research evidence.

Type of information source	Details	Examples
Citation indexes	These indexes provide access to journal articles which cite other journal articles. Using some key papers as the seeds, these information sources can be used to identify newer papers which may have cited the seed papers and hence may be reporting on a similar topic.	Science Citation Index Google Scholar Scopus
Hand-searching or electronically searching full text publications	Use a scoping search to identify key journal titles or conference proceedings that can be subjected to this technique. Decide which sections of the journals or proceedings will be searched in this way.	
Web-searching	Use portals to identify the web-pages of organisations conducting research or collating information in the field of interest or databases which might be searched. Internet search engines can be used to conduct wide-ranging searches of scientific publications on the internet.	Harvester Intute National Food Safety Learning Portal: Food Safety Database Science.gov
Contacting experts or manufacturers	Use an initial scoping search to identify frequently cited authors who may be approached for additional studies or data.	

#### 3.3.1. Citation indexes

Some information sources (notably Science Citation Index, Google Scholar and Scopus) allow cited reference searching. Such information sources link journal papers to other papers in which the original papers have been cited. This allows a searcher to look forward in time from the publication of a relevant article to identify additional studies that have been published since that point and which have cited the relevant article. Greenhalgh et al. (2005) have identified citation searching as an important adjunct to database searching and hand-searching the human health literature.

Related to citation searching is “snowballing”.<sup>6</sup> Unlike citation searches which search forward in time, snowballing will only find studies published before the source paper. Snowballing involves

<sup>6</sup> <http://hlwiki.slais.ubc.ca/index.php/Snowballing>. Last accessed: 14 August 2013

manually browsing the reference lists of highly relevant papers (both primary studies and reviews) that have been identified by the database searches. In addition to identifying further studies for possible inclusion in the review, this can also provide a means to validate the searches of bibliographic databases. If “snowballing” identifies many relevant studies that were not retrieved by the database searches this suggests that the search strategy may need to be revised to increase sensitivity.

### **3.3.2. Hand-searching or electronically searching full text journals and conference proceedings**

Hand-searching can usefully supplement a search of bibliographic databases as it can identify very recent publications that have not yet been indexed by electronic databases, as well as journal articles which have been included in databases but missed by the specific search strategy. A Cochrane Methodology Review concluded that a combination of hand-searching and database searching is required for full identification of relevant studies published in health journals (Hopewell et al. 2007).

Hand-searching involves manually scanning a publication cover-to-cover to identify all eligible reports of trials. Hand searching can also be carried out electronically by browsing through documents online. The reviewer should aim to identify all relevant material whether it appears in an article, abstract, news column, editorial, letter or other text (Sargeant et al. 2005).

The choice of titles to be searched in this way may be informed by an analysis of the results of database searches. Journals which contain the largest number of relevant studies can be considered strong candidates for this technique. The process of hand-searching and electronic-searching of full text material should be documented in detail as it forms part of the systematic review methods: details should include the full title of the journal or proceedings and the issues searched

### **3.3.3. Web-searching**

The last decade has seen significant changes in the extent and sophistication of search engines and federated search options where many resources on the internet are searched from one access point. However, there is limited evidence available on the relative yield and efficiency of searching wide ranging search engines (i.e. whether one or two or more are sufficient). There is also sparse evidence on the benefits of searching using search engines across several databases compared to searching the individual databases with their own, usually more sophisticated interfaces. Eysenbach et al (2001) assessed the value of internet searching to identify unpublished and on-going trials in human health topics. The authors concluded that whilst the Internet searches did identify unpublished trials, this had to be balanced against the increased resource use involved.

Searching the internet is likely to involve using a mix of approaches:

- searches of multinational, multidisciplinary search engines which search research publications, such as Science.gov;
- identification of key organisations through relevant organisation lists or portals such as National Food Safety Learning Portal: Food Safety Database;
- searches of the websites of relevant key organisations (research groups, funders, official bodies);
- searches of scientific literature via general search engines such as Google Scholar;

Internet searching should be carried out in as structured way as possible (with detailed recording of the sources searched and the search terms used) and screenshots of search results and internet documents should be retained to compensate for the dynamic nature of the internet where links are prone to change and resources may be removed without warning.

Some portals and search engines are listed in the EFSA inventory. This is a fast moving field and new search engines emerge or die every year, which can make it challenging to keep up to date.

#### **3.3.4. Contacting topic experts and manufacturers**

Topic experts, research groups and manufacturers may be able to supply information about unpublished research or alert reviewers to published studies not identified by the search strategy. Requests for information should include a list of studies already identified to help experts respond helpfully. Specific criteria for identifying and contacting individuals or organisations should be recorded a priori and fully documented (Sargeant et al. 2005)

Contacting experts can be a time-consuming process and evidence from the health literature suggests that the value of the process is unclear. Some researchers (Greenhalgh 2005) have concluded that this is an important method of retrieving studies for systematic reviews in human health, whilst others reported less fruitful results (Horton 1997).

In addition to contacting potential sources of trials directly, some reviewers may also set up a publicly accessible project web-site which lists the studies identified to date and invites submission of any that have been missed. An example of a systematic review team employing such a site can be found at [www.york.ac.uk/inst/crd/fluorid.htm](http://www.york.ac.uk/inst/crd/fluorid.htm).

Table 10 provides an example showing the process of information source selection for a systematic review of *Salmonella* in poultry.

**Table 10:** Worked example showing the process of information source selection for a systematic review of *Salmonella* in poultry

Method of identifying studies	Information sources selected	Explanation
Journal articles and other publications	<p>General:</p> <ul style="list-style-type: none"> <li>• MEDLINE and MEDLINE In-Process</li> <li>• Embase</li> <li>• CAB Abstracts</li> </ul> <p>Specific:</p> <ul style="list-style-type: none"> <li>• FSTA</li> <li>• AGRICOLA</li> <li>• AGRIS</li> <li>• Poultry Abstracts</li> </ul>	<p>To efficiently identify studies published in the journal literature.</p> <p>MEDLINE and Embase are key sources of clinical trials and also have limited coverage of veterinary journal titles (Grindlay et al. 2012)</p> <p>CAB Abstracts covers life sciences and has been shown by studies to have the strongest coverage of veterinary and agriculture journal titles (Kawasaki 2004, Grindlay et al. 2012).</p> <p>The remainder of the databases cover topics very specific to the review question (food science, agriculture and poultry science) and are therefore likely to contain relevant studies.</p>
Conference proceedings	<p>Conference Proceedings Citation Index Science. BIOSIS Citation Index</p>	<p>Both these resources index conference proceedings; this is a type of information not typically included in bibliographic databases.</p> <p>BIOSIS Previews can also be searched to identify published journal articles in the life sciences. However, the lack of unique journal titles indexed by BIOSIS means that it is not a priority information source for this purpose (Kawasaki 2004, Grindlay et al. 2012).</p>
Reports	<p>NTIS JSTOR ScientificWebPlus Science.gov</p>	<p>These sources all offer simple search interfaces but should provide access to technical reports as well as other grey literature.</p>

Method of identifying studies	Information sources selected	Explanation
Citation indexes	Science Citation Index	In addition to identifying published journal literature, the Science Citation Index allows the identification of any papers published since a relevant study by tracking citations forward in time.
Hand-searching or electronically-searching full text journals or conference proceedings	The proceedings of the following conferences: <ul style="list-style-type: none"> <li>• Annual Meeting of the Poultry-Science-Association</li> <li>• International Poultry Scientific Forum</li> <li>• Congress of the International-Society-for-Animal-Hygiene</li> </ul>	Indexes of conference proceedings, such as the Conference Proceedings Citation Index, alone are not sufficient to identify all relevant studies. (Glanville et al. 2012).  These three conferences were selected as a scoping search of the Conference Proceedings Citation Index showed that the largest number of relevant studies were presented in those conferences.
Web-searching	Search or browse web-pages of: <ul style="list-style-type: none"> <li>• Poultry Research Foundation</li> <li>• Poultry Research Centre</li> <li>• Centre of Excellence for Poultry Science, University of Arkansas.</li> <li>• Science.gov</li> </ul>	These organisations produce research in the relevant field; they may provide information about on-going or yet to be published research on their webpages.
Clinical trial registers	TEKTRAN Current Research Information System [CRIS]	Trial registries such as clinicaltrials.gov and Current Controlled Trials provide access only to human trials. The resources chosen are specifically designed to provide information about on-going or soon-to-be published research in agriculture. TEKTRAN is provided by the US Agricultural Research Service and CRIS by the US Department of Agriculture.
Contacting experts and manufacturers	Contact first authors of the papers such as: <b>Knap, I.</b> et al. (2011). <i>Bacillus subtilis</i> (DSM17299) significantly reduces <i>Salmonella</i> in broilers. <i>Poultry Science</i> 90 (8), pp. 1690-1694.	These are recent relevant trials identified during scoping searches of bibliographic databases. Tellez is a particularly frequently cited author in this topic area. Such experts may be able to provide information on

Method of identifying studies	Information sources selected	Explanation
	<b>Tellez, G.</b> et al. (2012) Probiotics/direct fed mircobials for Salmonella control in poultry. Food Research International 45, pp. 628 – 633).	unpublished research or research not identified during the database searches.

## 4. Practical issues

### 4.1. Peer review of search strategies

Systematic review best practice encourages the use of double independent reviewing for many tasks. Ideally search strategies should be peer reviewed by an independent information specialist; however it is recognised that not all searchers have access to this type of support locally. To support the possibility of peer review, informal reciprocal networks are being developed such as the PRESSForum (<http://pressforum.pbworks.com>) and information sharing discussion lists like [expertsearching@pss.mlanet.org](mailto:expertsearching@pss.mlanet.org). These initiatives in health care may be replicable in food and feed safety research.

Published guidance in the form of a checklist, known as Peer Review of Electronic Search Strategies (PRESS), is also available to assist with consistent peer review (Sampson et al. 2008; Sampson et al. 2009; McGowan et al. 2010). Table 11 presents the PRESS elements for the peer review of electronic search strategies adapted to reflect EFSA terminology and interests, and to include some additional questions. The checklist is not weighted, so the relative importance of the issues is not clearly presented. However, some of the issues are more crucial for successful searches than others. For example the successful translation of the research question into key elements is vital for a successful search.

**Table 11:** Adapted PRESS checklist for peer review of search strategies (Sampson, 2009) (new additions in italics)

Issue	Questions
Translation of the research question	<p>Has the research question been translated correctly into the search concepts which are needed (e.g. PECO, PIT, PO)?</p> <p>Are the key elements clear?</p> <p>Are there 'too many' key elements? (for example have four key elements been used and the results are very low, indicating potentially low sensitivity)</p> <p>Are any of the key elements too narrow or too broad?</p>
Boolean and proximity operators	<p>Does the search appear to retrieve too many or too few records?</p> <p>Are there any mistakes in the use of Boolean or proximity operators?</p> <p>Are there any mistakes in the use of nesting with brackets?</p> <p>If NOT is used, is this likely to result in unintended exclusions?</p> <p>Could precision be improved by using proximity operators (e.g. adjacent, near, within) instead of AND?</p> <p>Is the width of any proximity operators correct?</p> <p><i>Does the word order need to be considered?</i></p>
Indexing terms	<p>Are the subject headings/indexing terms relevant?</p> <p>Are subject headings/indexing terms missing?</p> <p>Are any subject headings/indexing terms too broad or too narrow?</p> <p>Are subject headings/indexing terms exploded where necessary and vice versa?</p> <p><i>If sub-headings are used, is their use helpful (i.e. not too focused)?</i></p> <p>Are sub-headings used instead of relevant subject headings or vice versa?</p> <p>Are both subject headings and free text terms (see below) used for each key element? If there is a reason provided for not</p>

Issue	Questions
Free-text terms	doing so, does the reason appear to be sound? Does the search miss any spelling variants? Does the search miss any synonyms? Does the search miss truncation or truncate at the wrong point? <i>If an acronym or abbreviation is used, a full text term or substantial part of a full text term should also be present.</i> Are apparently irrelevant or excessively broad free text terms used?
Spelling, syntax and line numbers	Are there any spelling errors (NOTE: some spelling errors may be deliberately included)? Are there any errors in system syntax (e.g. truncation symbols) or wrong line numbers?
Limits and search filters	Do any of the limits used seem unwarranted? Are any filters used appropriate for the topic? Are any potentially helpful limits or filters missing? Is any restriction to focus (major indexing terms) used and, if so, is there adequate justification for this?
Search strategy adaptations	Does the searcher indicate that the search strategy has been adapted for additional databases and/or interfaces? Are the adaptations available for review and if so are they correct?

#### 4.2. Managing references using EndNote

Bibliographic software can make the storage, de-duplication and management of references retrieved by electronic literature searches more efficient. Records can often be downloaded from information sources into software such as EndNote, and stored for use at various stages of the systematic review. EFSA uses EndNote in-house to support the production of its systematic reviews. EndNote offers de-duplication features to rapidly de-duplicate records obtained from several searches. It can also index records on several fields, including fields which can be defined by users (Custom fields). EndNote's Custom fields can be used to record the information source from which records were downloaded, the date of the search, whether the document is eligible for the review, notes on reasons for inclusion/exclusion, document ordering information (date, source, format, cost) and document storage information. EndNote supports the categorisation of records by providing the option to create virtual groups and PDFs can be linked to EndNote records to keep references and full text linked. It is also possible to link EndNote and Microsoft Word to generate the references for the final systematic review report if desired; references can be quickly formatted to meet different citation styles.

#### 4.3. Documenting the search process during the search

The search methodology must be documented and reported in detail to ensure transparency and enable the evaluation and replication of the strategy. The PRESS checklist (see Section 4.1) provides insights into some of the critical features of reporting the search:

- how the search is structured to answer the review question;
- the range of synonyms and other terms used to capture the key elements;
- the choice, use and justification of limits;
- the adaptation of the main strategy to the other information sources searched.

The EFSA guidance for those carrying out systematic reviews in food and feed safety state that the following must be recorded for each search (EFSA 2010):

- The name of the database;
- The date of the search for each database, and the date range searched;
- Any limits placed on the search such as language or publication status;
- The full search strategy (all terms and set combinations) and the number of records retrieved. This information should be copied and pasted for all databases where possible; retyping searches should be avoided as this may introduce errors.

Notes of key decisions which may impact on the review findings should be kept in a narrative format. This may include the effects of selecting specific search headings, limiting the search in a particular way, or adding a search filter.

## **5. Building research into literature searching projects**

The procedures for undertaking systematic reviews should be based on the best evidence from research. Research in information retrieval for systematic reviews is as important as research for other parts of the systematic review process because the information retrieval part of the systematic review is resource intensive. To make the most efficient use of resources it is important to know how many information sources need to be searched for a specific question, how searches can be structured to identify as many relevant records as possible while minimising irrelevant records, and how best to manage the information retrieval process to minimise the time spent in managing records and documents.

Research information can be identified from the scientific literature but it is also possible to build the evidence picture from conducting small research projects during and after a systematic review. Even if research activities are planned, detailed documentation of the search process and archiving of raw and processed search results should be undertaken. These data can be used for retrospective research and once the body of published systematic reviews in food and feed safety has reached a useful volume.

This section of the Technical Manual provides guidance on aspects of the information retrieval process which can be informed by research and suggests some standard approaches to conducting research projects during or after a systematic review. Many of the research examples are from systematic reviews of healthcare but the methods should be transferrable to reviews undertaken in food and feed safety.

### **5.1. Research into developing search strategies**

Developing search strategies is a complex process requiring adaptation for specific review questions, which are unique and may each pose different problems in development. However, some aspects of developing search strategies are more amenable to research and the results can save time by providing standard approaches to searching. The following aspects of search strategy design can be explored through research:

#### **5.1.1. Search filters**

Search filters (pre-designed search strategies) can be developed to identify studies which used specific methods (e.g. randomised controlled trials) or studies of specific populations (e.g. poultry). In healthcare there are many research-based filters available and the methods for designing and

validating search filters are now well developed (Haynes et al. 2005, Glanville et al. 2006). Search filters are typically developed outside of a specific systematic review, but do ideally require a gold standard reference list of known relevant studies for testing, which might be derived from one or more systematic reviews. Developing search filters in an evidence-based way requires adequate resources to develop a reference gold standard, identify candidate search terms, test the sensitivity and precision of the filters, and to try to establish more extensive performance data.

There is typically limited information on the performance of search filters beyond the data reported in the original publications describing the filters. To establish the performance of filters it is possible to test how filters perform in finding the relevant studies revealed by the systematic review process; this is another use of the relative recall method (Ritchie et al. 2007). The included studies identified by a systematic review form a gold standard: those studies can be identified in a specific information source and the ability of the search filter to find those studies provides data on its performance. When carried out over many reviews, it should be possible to establish whether the filter performs consistently.

### **5.1.2. 'Safe' approaches to removing unwanted populations or topics**

This may include approaches to excluding animal or human studies, or specific publication types such as editorials. For example, Wright and McDaid (2011) reported on how best to identify published retractions and explain why excluding some study designs from search strategies may also remove important information on retractions. They investigated whether MEDLINE, Embase and CENTRAL recorded notices of retraction in a clear and timely way by searching for 18 papers by an author (Reuben) that were known to have been formally retracted, based on retraction notices. All of the retracted papers in MEDLINE had been annotated appropriately, but only six per cent had been annotated in Embase. As a result Wright and McDaid have changed their searching practice to check all potentially included studies in MEDLINE to identify retractions.

### **5.1.3. 'Safe' approaches to running update searches**

Many information sources offer the option to run update searches based on an update code. The use of update codes, however, may not always be transparent and where cross-database searching is offered update searching should be undertaken with care. This is a key issue with the MEDLINE database where many different update codes are available and it is unclear which update codes should be used to ensure studies are not missed when seeking to restrict search results to those added since a previous search. The evidence on the availability and safety of using update search codes within specific food and feed safety databases may require investigation and documentation so that guidance can be offered on best approaches.

## **5.2. Testing different search strategies: which works best?**

Search strategies should be shown to be fit for purpose: that they find relevant studies. This aspect of testing search strategies can be carried out informally, by checking that a few known relevant documents are retrieved by the strategy. Alternatively, more formal testing can be undertaken, providing more robust evidence on the performance of the search strategies and providing information on the need for strategy adaptation or the need for wider searching or hand searching for topics which are difficult to capture in search strategies.

Another aspect of testing searches might be to inform reviewers when searching has retrieved 'enough' studies: there is little research evidence on 'stopping rules' but methods have been suggested to explore options for developing such rules (Kastner 2009).

### 5.2.1. Hand-searching

Hand-searching methods are well established (Hopewell et al. 2007b) although they may lag behind the recent developments in improved access to full text journals on journal websites and via services such as ScienceDirect. The challenges of a hand-searching project lie in the following areas:

- Selecting the journals or other resources to search;
- Deciding which elements of journals to search, for example are all supplements to be hand-searched, are all sections of a journal to be hand-searched (e.g. obituaries);
- Recording what has been hand searched;
- Deciding whether to hand-search all the supplementary materials available on electronic sites;
- Establishing the final issue to be searched (i.e. deciding on an appropriate cut-off date for searching);
- Managing the dynamic nature of electronic resources, for example how to cope with correspondence being added to journals, website changes and errata;
- Managing the work-load and training of the hand-searchers in order to reduce the possibility of operator error.

### 5.2.2. Relative recall

Relative recall (Sampson et al. 2006; Ritchie et al. 2007; Sampson et al. 2011) is helpful for exploring the reasons for non-retrieval of records from information sources. It allows comparison of the precision of searches within different databases and helps with establishing the prevalence of subjects within information sources. The strengths and weaknesses of this approach are shown in Table 12.

Relative recall involves identifying systematic reviews which have been conducted using sensitive searches of many information sources. The included studies of those reviews are regarded as a quasi-gold standard set of records because of the extensive nature of the searches conducted to create the reviews. The included studies are treated as a set of relevant records and the performance of various information sources can then be assessed, in terms of the number of relevant records retrieved from the sources and the number of records uniquely retrieved from each source. From this method a list of high-yield and low-yield information sources can be identified along with information on the degree of overlap. Since the relative recall approach relies on identifying well-conducted systematic reviews that use high-quality search methodology, any relative recall exercise should include an assessment of the quality of the searches conducted in the original review.

YHEC (Glanville et al. 2012) undertook the following process for each systematic review subjected to a relative recall exercise:

- The characteristics of the systematic review were recorded: the review question, inclusion criteria, information sources searched, and number of included studies. An EndNote Library was created to collate the bibliographic references for the included studies. This formed the gold standard reference list.
- Each bibliographic reference was searched for within the information sources reported in the systematic review. Information sources not included in the review but relevant to the topic

were also searched. The EndNote record for each reference was labelled to show the information sources which contained that bibliographic record. This permitted easy identification of the references found using each information source.

- The yield of each information source was recorded in a table and the relative recall of the source was calculated as follows:

$$\frac{\text{Number of included studies found in each source}}{\text{Total number of included studies in the review}}$$

- The EndNote Library was searched using the labels to explore the best combination of information sources for yield. The number of studies retrieved by each combination and the relative recall was recorded in a table.
- Overlap between sources and the unique studies retrieved by each source were identified using the EndNote search function.
- Any studies not identified by the reported sources were explored further to try to identify how the reports might have been retrieved by the systematic review team.
- The original search strategies reported in the systematic review were re-run. Any reports that were indexed in the information source, but not retrieved by the strategy, were identified and the reasons for their non-retrieval were explored.
- Key messages from these exercises were reported along with any limitations of the relative recall studies.

**Table 12:** Strengths and weaknesses of the relative recall method

<b>Strength</b>	<b>Weakness</b>
Relatively quick and easy to carry out	Relative recall cannot ascertain the number of missing references.
Will not be impacted by order of information source searches	This is only as good as the search strategies used in the original review.
Provides individual information source yield and allows identification of unique yields from specific information sources. This helps reviewers to prioritise the information sources for searching or selection.	The searchers may have included a search filter which could impact the yield.
Does not require extensive and careful recording of all the individual searches conducted for the review.	This works best if the strategies used in different information sources are very similar; comparisons are less appropriate if strategies have been extensively adapted (e.g. from a sophisticated MEDLINE search to a strategy which has run in a single search line interface such as Google).

### 5.3. Assessing the yield and unique yield of searches of information sources

To understand which information sources need to be searched for which questions, information on the relative yield and overlap of information sources is required. If an information source, after repeated

searching to inform different systematic reviews, offers no additional unique bibliographic records, then it may be possible to exclude that information source from future searches for similar questions. This decision can only be made after repeated testing. However, such testing is relatively straightforward to undertake using the relative recall method. If conducted as standard at the end of every systematic review, the information gained can be used to build a performance picture for each information source. The data can also be used to estimate the number of bibliographic records missed by a search.

### 5.3.1. Capture-recapture

Capture-recapture can be used both to test the performance of search strategies and to assess the number of studies missed by a systematic review. The use of capture-recapture within systematic reviews has been reported in several studies (Spoor et al. 1996; Bennett et al. 2004). It can be achieved by hand-searching a sample journal and running a search strategy on information sources indexing the same journal (Spoor et al, 1996). The number of relevant records identified by each process is then used to gain a statistical estimate of what has been missed by all searches conducted (Spoor et al 1996).

### 5.3.2. Other methods

There are other methods to identify which information sources would be most useful for answering specific questions. One example, for questions on herbal and dietary supplements, is provided by Sweet and colleagues, who searched 14 information sources to identify answers to fifty questions, rated by difficulty (Sweet et al. 2003). The percentage of responses for each of the possible scores for each information source overall and by category of question was determined. The electronic databases (Natural Medicine Comprehensive Database, Micromedex) and the Internet site (The Natural Pharmacist) were estimated to be overall the most helpful information sources for information on herbal and dietary supplements. The use of such rating and coding systems are likely to be highly topic specific.

## 5.4. Building a search strategy collection

Developing search strategies is time consuming and strategies have to be adapted to suit a range of information sources, many of which will have unique indexing languages. Being able to access a library of strategies which have already been developed may save time for future searchers. However, developing and maintaining a strategy collection and providing ways to search it, also require resources. In addition, strategies need to be updated as databases and nomenclature change over time. The trade-offs may be such that despite apparent advantages such a resource is not cost-effective in practice. It should be noted that in health care systematic reviews, such a resource has not been developed and search strategy (filter) collections have been focused on study methods.

## 5.5. Developing the inventory

The EFSA Inventory has been added to a searchable database. Instructions for searching the Inventory and for adding new information sources are provided in an accompanying manual ([citation required from EFSA](#)).

## 5.6. Keeping up to date with research on electronic literature searching

Searchers should keep up-to-date with new evidence on information retrieval, particularly research specific to food and feed safety. Although this research-base is currently limited, interest in the application of systematic review techniques (including effective literature searching) appears to be growing (Sargeant et al. 2006b).

Bibliographic databases such as MEDLINE, CAB Abstracts, and Science Citation Index are an important method to flag newly published research. Many information sources searches allow a search strategy to be saved and an alert created to inform the searcher of any additional material published since the search was first run. The following strategy has been developed (Glanville et al. 2012) to identify studies on information retrieval in food and feed safety.

Database: Ovid MEDLINE(R) <1946 to May Week 2 2012>

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1  "Information Storage and Retrieval"/
2  (search adj2 strateg$).ti,ab.
3  (information adj2 retrieval).ti,ab.
4  ((electronic or bibliographic or database$ or literature or evidence or systematic) adj2 (search or
searches or searching)).ti,ab.
5  (handsearch$ or (hand adj3 search$) or (manual$ adj3 search$)).ti,ab.
6  (journal search$ or full text search$).ti,ab.
7  ((grey or gray) adj2 literature).ti,ab.
8  ((publication or language) adj2 bias).ti,ab.
9  or/1-8
10 exp Food/
11  Food Additives/
12  exp Food Preservatives/
13  exp Food Preservation/
14  exp Food Contamination/
15  exp Foodborne Diseases/
16  exp Food Handling/
17  Food Inspection/
18  exp Animal Feed/
19  exp Animal Welfare/
20  exp Veterinary Medicine/
21  Veterinary Drugs/
22  Veterinarians/
23  Pesticides/
24  (food$1 or feed$1).ti,ab.
25  (animal$1 adj2 (health or welfare or cruelty)).ti,ab.
26  (veterinary or veterinarian$).ti,ab.
27  ((foodborne or food borne) adj3 disease$1).ti,ab.
28  ((food or dietary) adj2 supplement$).ti,ab.
29  ((food or meat) adj3 inspection).ti,ab.
30  (pesticide$ or fungicide$ or herbicide$).ti,ab.
31  or/10-30
32  9 and 31
  
```

Table 13 provides a list of useful sources of information on information retrieval techniques. Many of the resources are regularly updated to reflect new research.

**Table 13:** Sources of information on information retrieval techniques

Source	Access information
Cochrane Handbook searching chapter	<a href="http://www.cochrane-handbook.org/">http://www.cochrane-handbook.org/</a>
CRD guidance	<a href="http://www.york.ac.uk/inst/crd/pdf/Systematic_Reviews.pdf">http://www.york.ac.uk/inst/crd/pdf/Systematic_Reviews.pdf</a>
Campbell Collaboration Information Retrieval Guide	<a href="http://www.campbellcollaboration.org/resources/research/new_information_retrieval_guide.php">http://www.campbellcollaboration.org/resources/research/new_information_retrieval_guide.php</a>
The Collaboration for Environmental Evidence Library	<a href="http://www.environmentalevidence.org/Authors.htm">http://www.environmentalevidence.org/Authors.htm</a>
Guidance from other HTA agencies e.g. EUNetHTA	<a href="http://www.eunethta.eu">http://www.eunethta.eu</a>
Cochrane colloquia	Abstracts are available at <a href="http://www.cochrane.org/events/colloquia">http://www.cochrane.org/events/colloquia</a>
HTAi vortal	<a href="http://www.htai.org/index.php?id=579">http://www.htai.org/index.php?id=579</a>
HTAi conference abstracts	<a href="http://www.htai.org/index.php?id=423">http://www.htai.org/index.php?id=423</a>
Key journals	For example, International Journal of Technology Assessment in Healthcare, Research Synthesis Methods, Journal of Clinical Epidemiology

### 5.7. Building gold standards for developing and testing search filters

The value of having gold standards of known relevant records is that they can be used for testing search strategy performance and for developing and testing new search filters.

Gold standards are usually developed by hand-searching journals or subsets of information sources (for example all the records about poultry in a specific information source). The hand-search process involves looking at each item (a journal article or a database record) and making an assessment of the relevance of the item or record to the topic of the gold standard. The resulting relevant records form a gold standard. The creation of a gold standard requires careful planning and should be guided by a research protocol defining the topic being sought, the eligibility criteria for assessing relevance and the process for identifying records.

Quasi-gold standards can also be established by relative recall methods as described in Section 5.3.2.

### RECOMMENDATIONS

Research evidence to inform more efficient evidence retrieval in the context of systematic reviews of food and feed safety is required for many topics, including the following:

- which databases offer the greatest yield of relevant records for different topics;
- which databases in combination offer the best yield of relevant records for different topics;
- efficient search filters to identify specific study designs in a range of information sources, taking account of specific features available in each information source;

- the value of searching for grey literature in terms of the yield of information sources and the impact of including evidence from grey literature on the effect size of the systematic review;
- the extent of publication biases in research in food and feed safety.

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**Appendix/Appendices****A. EFSA DATABASE SUBSCRIPTIONS****E-JOURNALS:**

WILEY BLACKWELL STM COLLECTION with full access since 1997

TAYLOR&FRANCIS ST+SSH COLLECTIONS AND FOOD ADDITIVES AND CONTAMINANTS A&B with full access since 1997

SPRINGER COLLECTION with full access since 1997

ELSEVIER FREEDOM COLLECTION AND ALL THE FOLLOWING TITLES: Animal Feed Science and Technology, Applied Animal Behaviour Science, Food and Chemical Toxicology, International Journal of Food Microbiology, Preventive Veterinary Medicine, Trends in Biotechnology, Veterinary Microbiology with full access since 2007

CAMBRIDGE UNIVERSITY PRESS COLLECTION with full access since 2002

NATURE ; NATURE NEWS; EUROPEAN JOURNAL OF CLINICAL NUTRITION; N. BIOTECHNOLOGY; N. NATOTECH; NATURE REVIEWS GENETICS; NATURE REVIEWS MICROBIOLOGY with full access since 2007

SAGE STM COLLECTION with full access since 1999

OXFORD UNIVERSITY PRESS Life sciences collection with full access since 1996

COCHRANE COLLECTION PLUS with full access to all published volumes

“FOOD LAB PACK” - AMERICAN CHEMICAL SOCIETY including the following titles Journal of agricultural & food chemistry, Journal of the American chemical society, Journal of organic chemistry, Journal of natural products, Nano letters, Analytical chemistry, Environmental science & technology, Organic letters, Chemical & engineering news archive articles, relevant chapters from the ACS symposium online with full access since 1996

SCIENCE with full access since 1997 & SCIENCE EXPRESS

JOURNAL OF FOOD PROTECTION with full access since 1994

AMERICAN JOURNAL OF CLINICAL NUTRITION with full access to all published volumes

JOURNAL OF AOAC INTERNATIONAL with full access to all published volumes

VETERINARY RECORD – BMJ with full access since 2004

JOURNAL OF TOXICOLOGY AND ENVIRONMENTAL HEALTH –PART A & B- with full access since 1998

FOODBORNE PATHOGENS AND DISEASES with full access since 2004

**DATABASES (via Web of Knowledge):**

Web of Science<sup>®</sup> (1975-present)

- Science Citation Index Expanded (1975-present)
- Social Sciences Citation Index (1975-present)
- Arts & Humanities Citation Index (1975-present)

Current Contents Connect<sup>®</sup> (1998-present)

CABI : CAB Abstracts<sup>®</sup> (1910-present)

FSTA<sup>®</sup> - the food science resource (1969-present)

MEDLINE<sup>®</sup> (1950-present)

Journal Citation Reports<sup>®</sup>