



How to conduct a systematic literature search

A step-by-step manual

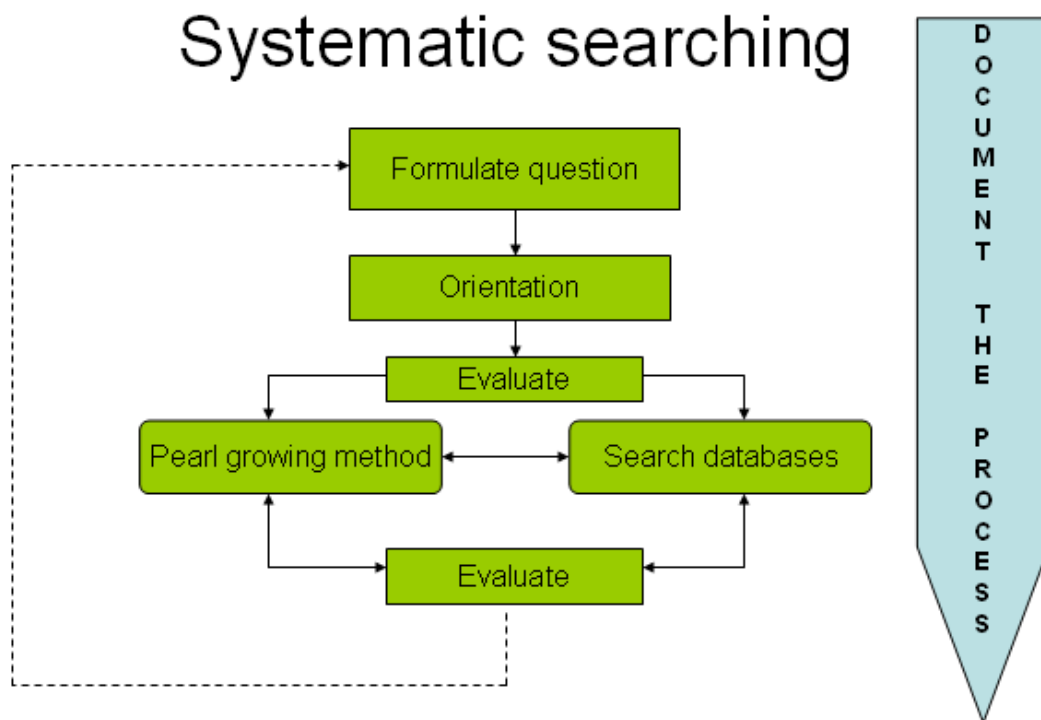


Introduction

This manual describes how to systematically conduct a search focussing on the biomedical database PubMed. Once a PubMed search strategy has been completed, it can be easily translated to search other databases. In the appendix the translation to the databases Embase and Web of Science is described. Some knowledge on searching is presumed.

Hint : Open a blank Word to document your search activities. This allows you to keep control of the searching process and enables to make adjustments and try out different strategies.

This diagram shows the global steps involved in systematic searching. Generally, it can be applied to all scientific research questions.



1. Formulate the search question

The PICO format is an instrument for formulating an answerable search question by splitting up the question and defining the components or concepts. Alternatively, you can use the tripartite question:

PICO	Tripartite Question	Terms
patient/population/problem	domain	
intervention	determinant	
comparison/control		
outcome	outcome	



2. Orientation

Reading around your research topic is important to find relevant terminology and to get the bigger picture on your subject. This will help composing a good search strategy.

Sources for orientation may be:

- Internet: Google, Google Scholar, Wikipedia, governmental sites, institutional sites
- Books, dissertations, e-books: use the [Leiden Catalog](#) at the Walaeus Website
- PointOfCare-tools: UpToDate (see [database list](#) at the Walaeus Website)
- Meta-search engines like TRIP (internet, [database list](#) at the Walaeus Website)

Keep track of the sources you use. Write down title, year, pages, authors, and URL and access date in case of a website. Formats for citing specific sources such as journal articles or books are shown in [Citing Medicine](#)*

→ Make a note of synonyms and relevant variants in terminology
Already after orientation you may find out you need to adapt your search question.

3. Pearl growing method / snowball method

Pearl growing method or snowball method means the retrieval of citations from the orientation sources (going from recent to older)

- Use the cited references from the orientation sources (going back in time)
- Sometimes citing references ("cited by") are presented with a reference, showing more recent related references
- Trace the original articles
- Keep track of all useful references in the Word document

4. Compose a Search strategy for PubMed

- Start PubMed via the link on the Walaeus Library website; this version is enriched with link resolvers to get access to the full text collection if available
- Select the main component or concept from your PICO to start with

A component may exist of several concepts; search at first for the most significant concept.

Example:

P = "adult with Type 2 Diabetes Mellitus". Construct a search strategy for "Type 2 DM" only. Since most cases of this disease concern adults, it is not necessary to search for this age group explicitly.

Whereas with P = "child (<12 years of age) with Type 2 Diabetes Mellitus" the age group is an important discriminating concept that requires a separate formulation.

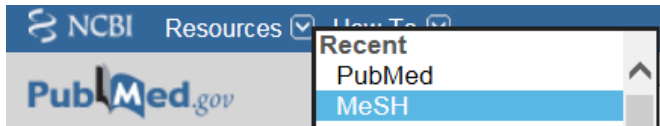
- Compose a search strategy for this component, copying/pasting from PubMed and the MeSH Database to Word and vice versa

* Patrias K. Citing medicine: the NLM style guide for authors, editors, and publishers [Internet]. 2nd ed. Wendling DL, technical editor. Bethesda (MD): National Library of Medicine (US); 2007 - [updated 2011 Sep 15; cited 2013/28/01]. Available from: <http://www.nlm.nih.gov/citingmedicine>

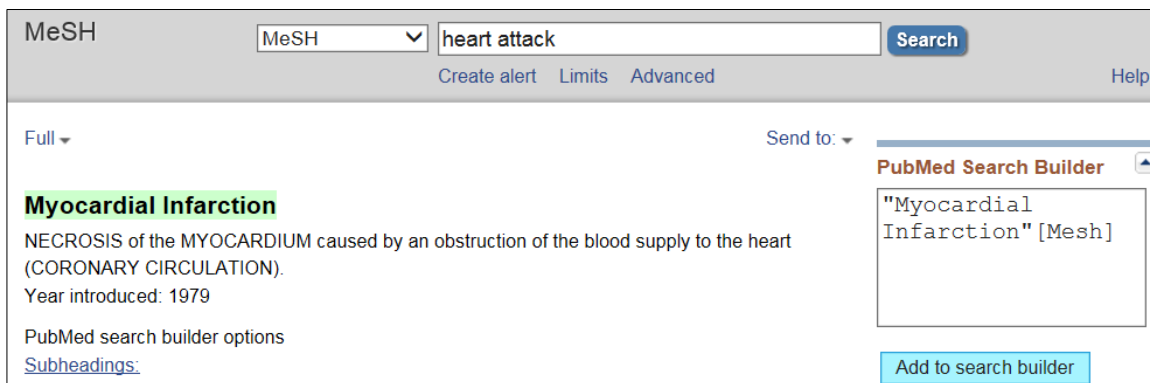


→ Use the Boolean operator *OR* to combine synonyms

Use the MeSH database to find relevant MeSH-terms. MeSH (Medical Subject Heading) is a specialized vocabulary of medical subject terms, enlisted in a hierarchy. They are used by PubMed indexing specialists to label references according to their subject. MeSH terms cannot be created by the end user, they are provided by PubMed.



In the MeSH database select the right term and click Add to Search Builder. Now the term is presented in the right format, with double quotes and the field tag [MeSH]. Copy this to Word.



Searching with only MeSH-terms will exclude recent references that are not yet indexed and do not have MeSH terms. For this reason additional terms need to be formulated for the same concept.

Combine free text search terms with MeSH terms, all connected with OR. Free text terms are words and phrases you would expect in the titles and abstracts of relevant references.

Field tags for free text search are:

[tw] , [text word] and [all fields] for "text words anywhere in PubMed"

[tiab] for terms in title or abstract of references and keywords provided by the author

[ti] for title words.

For an explanation of field tags see

http://www.ncbi.nlm.nih.gov/books/NBK3827/#pubmedhelp.Search_Field_Descrip

Use "double quotes" to prevent unwanted term translations.

A typical search strategy for one component will have the following format:

"term1"[MeSH] OR "term1"[tw] OR "synonym1"[tw] OR "synonym2"[tw]

For example, a search strategy for the component "heart attack" may be as follows:

"Myocardial infarction"[MeSH] OR "myocardial infarction"[tw] OR "myocardial infarctions"[tw] OR "heart attack"[tw] OR "heart attacks"[tw] OR "cardiovascular stroke"[tw] OR "MI"[tiab]

Copy/paste the complete text block to Pubmed and check for any errors in the Query Translation by clicking Search Details.

**Hint:**

Key articles are relevant references on your subject that you already know in advance. Check MeSH terms assigned to those key-articles to detect missed MeSH-terms useful for your subject.

Always study the definition and the context of a MeSH term in the MeSH Database.

- Select the second component of the PICO and compose a separate search strategy for this subject in Word as described above: a combination of a MeSH term and free text variants combined with OR
- Test the second component in PubMed

Combine the two search strategies to find the overlap:

- Put each component within parentheses (.....)
- Place the the Boolean operator *AND* between the components and make it into one text string.

Typical format of a combined search strategy:

(Search strategy component 1) AND (Search strategy component 2) AND (Search strategy component n)

- Copy the complete combination as a text string to PubMed. The number of retrieved references should be less than each of the individual components
- Check the retrieved references for relevancy. Keep in mind that a set will never yield 100% relevancy.

If the results are not satisfying, try a different combination of components or try the next steps to make the results more specific.

5. Limit the number of references

The number of results can be limited by making the search more specific. There are four methods to limit the initial number of references in a controlled way. They can either be applied separately or combined.

1. Add an extra component

Adding an extra component from your PICO will specify the result.

- Formulate a search strategy for the new component or concept, combining MeSH terms and free text
- Document the new search string in Word
- Test the new component in PubMed and check for errors
- In Word, put parentheses around the new component and combine it with the initial search strategy; use the operator *AND*
- Try the extended search strategy in PubMed. You should retrieve less references that are more specific.

2. Emphasize one or more components

A reference in PubMed is tagged with about 15 MeSH-terms, of which about 3 are indicated as Major MeSH. Major MeSH-terms concern the main topic of the article.



You can specify the search results by searching for Major MeSH-terms only in one or more components. Instead of [MeSH] the field tag [Majr] is applied. The general free text field tags [tw] or [all fields] also need specification. Replace them by either [tiab] or [ti].

Replacing the field tags in your Word document is easy:

- Copy and paste the search strategy you want to adjust. In this way the original strategy remains intact. Select the copy text by highlighting and use the function *Editing>Find and Replace* or *Ctrl- H* to replace [MeSH] by [Majr] and [tw] or [All Fields] into [Tiab] or [Ti]

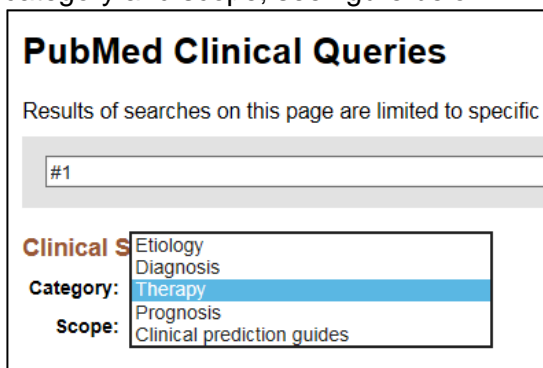
For the component "heart attack" this may look as follows:

"Myocardial infarction"[Majr] OR "myocardial infarction"[ti] OR "myocardial infarctions"[ti] OR "heart attack"[ti] OR "heart attacks"[ti] OR "cardiovascular stroke"[ti] OR "MI"[ti]

- Copy and paste the new search strategy into Pubmed, note the reduced number of results and evaluate them.

3. Use a search filter

PubMed offers ready made search filters, the *Clinical Queries*. This feature is available from the PubMed home page, in the central column PubMed Tools > Clinical Queries. Clinical Queries are only suitable for a limited search, e.g. for a Critical Appraisal of a Topic: CAT. Enter your search strategy and click search. Choose your clinical study category and scope; see figure below.



For comprehensive searches e.g. to write a systematic review or a meta-analysis you should use more sensitive filters. The Walaeus Library staff may advise you on this topic.

Other filters are presented on the left hand side in the PubMed results window. Application of these filters adds only MeSH terms as an extra component to your search strategy. As a consequence all references that do not have MeSH Terms will be lost. This does not apply to the Filters *Publication Dates* and *Languages*.



4. Use subheadings

A subheading specifies a certain aspect of the MeSH term. Every MeSH comes with its own set of subheadings, depending on the category. You can select one or more MeSH/subheading combinations in the MeSH database.

- Open the *MeSH-database*
- Select a *MeSH-term* and open the full page
- Tick one or more *subheadings*
- Click *Add to Search Builder*
- Copy/paste this combination to your Word document and test it in PubMed

In the example below the component "the epidemiology of heart attacks" is formulated as follows: "Myocardial Infarction/epidemiology"[MeSH]

The screenshot shows the MeSH database search interface. At the top, there is a search bar with 'heart attack' entered and a 'Search' button. Below the search bar are links for 'Create alert', 'Limits', 'Advanced', and 'Help'. The main content area displays the MeSH term 'Myocardial Infarction' with its definition: 'NECROSIS of the MYOCARDIUM caused by an obstruction of the blood supply to the heart (CORONARY CIRCULATION). Year introduced: 1979'. Below the definition are 'PubMed search builder options' and a list of subheadings: 'analysis', 'anatomy and', 'enzymology', 'epidemiology' (checked), 'physiology', and 'physiopathology'. On the right side, there is a 'PubMed Search Builder' window showing the selected MeSH term and subheading: '"Myocardial Infarction/epidemiology"[Mesh]'. Below this window are buttons for 'Add to search builder', a dropdown menu set to 'AND', and a 'Search PubMed' button.

NB: because this formula does not include free text, only references indexed with MeSH terms will be retrieved. This can be useful for an orientational search on the subject, though. For a complete search, adding free text remains necessary.

The field tags of the free text terms have to be changed as well to either [tiab] or [ti]. By retaining [tw] or [all fields] as free text, PubMed will find the MeSH without subheadings, which will undo the specification. Also, an extra strategy for the concept of the subheading needs to be formulated and linked to the initial subject.

Replacing the field tags in your Word document is easy:

- Copy the search strategy you want to adjust. In this way the original strategy remains intact. Select the copy text by highlighting. Use the function *Editing>Find and Replace* or *Ctrl- H* to change either [tw] or [All Fields] into [Tiab] or [Ti]
- Combine the adapted search string with the Mesh/subheading, using OR
- Copy and paste the new search strategy into Pubmed, and evaluate the results

A complete search for "the epidemiology of heart attacks" could be:

"Myocardial Infarction/epidemiology"[MeSH] OR (("Myocardial infarction"[MeSH] OR "myocardial infarction"[tiab] OR "myocardial infarctions"[tiab] OR "heart attack"[tiab]) AND ("Epidemiology"[MeSH] OR "Epidemiology"[tw] OR "Epidemiologic"[tw] OR "Epidemiological"[tw]))

Note the extra pair of parentheses, needed to keep the concepts together.



6. Check your results

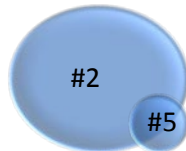
Check the search strategy with Boolean operators AND and NOT

Are key articles present?

Check whether relevant articles you already know (key articles) are present in your resulting set of references. This is done using the Boolean operator *AND*.

First you have to identify your key articles. There are 3 ways to find known items:

1. Use the *Single Citation Matcher* (link in the central column on the PubMed home page)
 2. Type the title of the article in the search box
 3. Type the PubMed ID (PMID) of specific references in the search box, separated by spaces
- Combine keyarticle references, if more than one, with *OR* to create one set, e.g. #5
→ On the PubMed home page, click Advanced. Trace the set of the total search in the



Search History, e.g. #2

- Type both set numbers in the search box above the Search History, preceded by #
→ Use the operator **AND** to combine them, e.g. #2 AND #5
→ Click *Search*

If all key references are present in the set, the result will be a new set with exactly the number of references from #5. If one or more references from #5 are missing in #2, check out why this has happened. Check their MeSHTerms and free text terms. Adapt your search strategy if necessary by adding the extra terms to your search strategy, to also include the missing references in the total set.

Which articles are lost?

Narrowing your search will result in the loss of references. To find out which articles are lost you can compare sets using the Boolean operator *NOT*.

Do not use this operator in your textual search strategy, since you may lose relevant



references. The big circle is set #3 with the largest number of references. Set #7 is the result of narrowing search #3, with less references.

To assess the loss of references after limiting the search, set #7 is subtracted from #3. The part in lighter color contains the lost items.

- Look up the number of the larger set in *Advanced > Search History* e.g. #3
→ Trace the set number of the narrowed search, e.g. #7
→ Type both set numbers in the search bar above the Search History, combined with **NOT**, e.g. #3 NOT #7. The new set contains references belonging to set #3, but not to #7



- Consider whether the articles in this new set would be relevant to your question or whether it is OK to leave them out.

7. Increase the number of references

There are several ways to expand the resulting number of references:

- Delete one whole, less important component from your search strategy
- Add more synonyms and variants to one or more components. Key articles may be a source of extra terms
- Use a broader MeSH-term, that is a term higher in the semantic hierarchy
- Use the pearl growing method with a key article: check the Bibliography for older items or perform a Cited Reference search in Web of Science for newer references
- Perform the search in other databases: See [Databanken en Cataloqi](#) on the Walaeus Website and [Catalogus Leiden](#) > Find databases

8. Document your search activities

Several options exist for a report on your search activities.

- Save your orientation sources and search strategies in a Word document
- Make a note of resulting number of hits and dates of searching
- Copy/paste the PubMed *search history* table to your Word document
- Save the best search strategy to a "MyNCBI" account for later use. A periodic e-mail *Alert* can also be set.
- Use a reference management program such as EndNote for collecting and managing references from diverse sources.

Appendix

Translate a PubMed search strategy for Embase and Web-of-Science

Formulating a search strategy for PubMed may be time consuming. However if you subsequently search for the same subject in Embase and Web Of Science (WoS), you will save a lot of time. You only need to convert your PubMed search strategy into the formats of the alternative databases. The main part is done by using *Find and Replace* in Word.

This appendix shows the main principles of translating a strategy. Consult the Walaeus Library staff whenever you need assistance.

Note:

Neither Embase nor WoS does accept "curly" or *smart* quotes, only "straight" quotes. To change the setting in Word choose File > Options > Proofing > *Autocorrect Options*. Both on the tab "*Autoformat as you type*" and on the tab "*Autoformat*" > remove the tick before "*Straight quotes with smart quotes*"

1. Embase



Embase has its own thesaurus of indexing terms called Subject Headings. Often they are not exactly the same as the PubMed MeSH-terms. Therefore, it is necessary to check each Mesh term for its Embase equivalent in the Embase Thesaurus.

Note:

- Subject headings are tagged by the suffix forward slash / .
- Embase free text field tags are written between periods: Pubmed [ti] = Embase .ti.
- General free text terms [tw] and [all fields] are searched with .mp. (= multi purpose)
- Embase does not automatically include narrower terms (exploding). The prefix **exp** is needed to explicitly include all underlying Subject Headings.

- Copy the PubMed search strategy to another part of your Word document; this leaves the PubMed strategy intact.
- Select the copy text by highlighting
- Select *Editing> Find and Replace* or use *Ctrl-H*
- Replace all of the [MeSH] field tags by a / (forward slash) > Do you want to search the remainder of the document? > click NO
- Replace all of the [tw] field tags by .mp. (= multi purpose) > Do you want to search the remainder of the document? > click NO. The same for [all fields]
- Check each term with a slash / whether it is the correct Embase *Subject Heading*: Enter the term in the Embase search box (without the /) and click *Search*. If necessary, replace the term in your strategy by the correct Embase Subject Heading. Add **exp** in front of the term (with interspacing) to explode the Subject Heading and include underlying terms.

PubMeds "**myocardial infarction**"[MeSH] converted to Embase syntaxis is:
exp heart infarction/

- To emphasize or focus on a Subject Heading (= PubMed Major MeSH), place an asterisk in front of the term, without interspacing, e.g. **exp *heart infarction/**
- To perform a free text *title search*, replace .mp. by .ti.
- To perform a free text *title and abstract* search, replace .mp. by .ti,ab.

Example strategy in PubMed on "heart attack" :

"Myocardial infarction"[MeSH] OR "myocardial infarction"[tw] OR "myocardial infarctions"[tw] OR "heart attack"[tw] OR "heart attacks"[tw] OR "cardiovascular stroke"[tw] OR "MI"[tiab]

Converted to Embase:

exp heart infarction/ OR "myocardial infarction".mp. OR "myocardial infarctions".mp. OR "heart attack".mp. OR "heart attacks".mp. OR "cardiovascular stroke".mp. OR "MI".ti,ab.

Emphasize by Focussing the Subject Heading and performing a Title search:

exp *heart infarction/ OR "myocardial infarction".ti. OR "myocardial infarctions".ti. OR "heart attack".ti. OR "heart attacks".ti. OR "cardiovascular stroke".ti. OR "MI".ti.



Note: On average Embase will yield more references than PubMed with an equal search strategy. This is due to the fact that Embase adds far more keywords to each reference than PubMed.

2. Web of Science

Web of Science (WoS) has no indexing terms or subject headings, so you need to make an comprehensive free text search strategy. Variants from PubMed and Embase can be useful.

WoS allows for subject searching in so-called topics or for title words, using the prefixes TS= and TI=.

- Copy the PubMed search strategy to another part of your Word document; this leaves the PubMed strategy intact.
- Select the copy text by highlighting
- Select *Editing > Find and Replace* or use *Ctrl-H*
- Replace all of the field tags (MeSH and free text) with *blank (i.e. nothing)* > Do you want to search the remainder of the document? > click NO
- Remove redundant and duplicate terms and add terms from the Embase Thesaurus if desired.
- For a general free text search, put parentheses around each component. Put the prefix **TS=** in front of each without interspacing. TS means Topic Search.

Example strategy in PubMed on "heart attack" :

"Myocardial infarction"[MeSH] OR "myocardial infarction"[tw] OR "myocardial infarctions"[tw] OR "heart attack"[tw] OR "heart attacks"[tw] OR "cardiovascular stroke"[tw] OR "MI"[tiab]

Converted to Web of Science:

TS=("Myocardial infarction" OR "myocardial infarctions" OR "heart attack" OR "heart attacks" OR "cardiovascular stroke" OR "MI")

- To perform a title word search, simply replace **TS=** by **TI=**

Example:

TI=("Myocardial infarction" OR "myocardial infarctions" OR "heart attack" OR "heart attacks" OR "cardiovascular stroke" OR "MI")

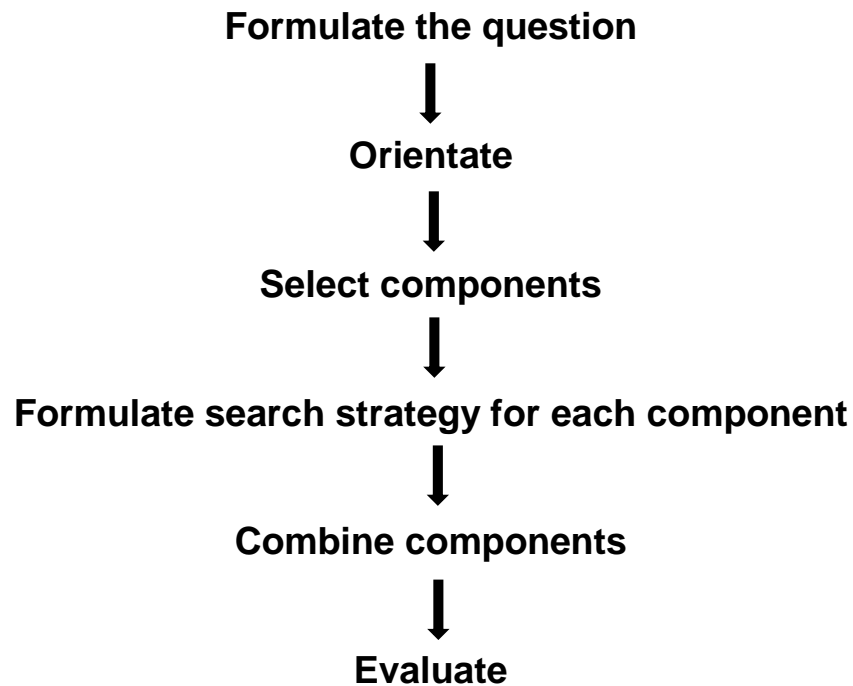
- Quotation marks turn off the *Lemmatization* in WoS. *Lemmatization* adds synonyms, spelling variants etc. to a search but the exact algorithm used is unclear.

In WoS, change Basic Search > **Advanced Search** and copy and paste the search strategy from Word into the search box > Search.

Note: On average a similar search in WoS yields less references compared to PubMed. This can be partly explained by the absence of indexing terms in WoS and partly its contents, not exclusively focussed on biomedical literature. In WoS therefore, usage of synonyms and spelling variants is crucial.



Summarizing: The process of searching



Too many references?

↓
Limit your search

- Add an extra component
- Specify by major MeSH/title word
- Specify by using a filter
- Specify by using subheadings

Too few references?

↓
Expand your search

- Add more variants within a component
- Leave out one whole component
- Use another database:

Embase
Web of Science
PsycInfo
CINAHL

.....