STEP 2
## Information Search

The second step in EBM is searching for *I*nformation (F*I*RE) on the Web. It is important to realize that there are many different search pathways and not one "absolutely right" search outcome. So try different search methods to find articles of interest. The overarching strategy in database searches is first to do as wide a search as possible to increase the probability of the articles you are interested in being included (secure a high level of sensitivity) and then apply restrictions to eliminate articles that you are not interested in (increase the specificity). The goal is to retrieve all relevant articles (100% sensitivity) but no irrelevant ones (100% specificity) – a goal which is of course impossible to fully achieve. In this section you will see an example of how you can reduce an initial "hit" comprising more than one million references to just 27.

◯ : Results of your search

● : Articles you looked for

0% sensitvity
0% specificity

100% sensitvity
~20% specificity

100% sensitvity
~50% specificity
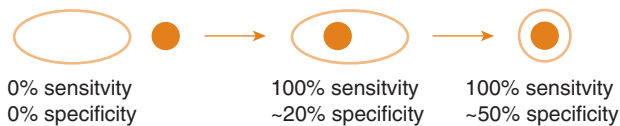
The main steps of the search procedure in PubMed and other databases are as follows:

1 Do a wide search (secure a high level of sensitivity in your search).

2 Restrict your search results and reduce the number of irrelevant hits (increase the specificity).

3 Use a good hit to find other relevant articles.

Make a wide search with high sensitivity

In order to make a wide search, it is necessary to try different strategies, check the outcome and follow-up items that seem to work. Again, there is no "absolutely right" outcome and you have to proceed by trial and error. There are two main search strategies and you should make use of both of them:

• Free textword searches in which you use your own search terms.
• Searches with MeSH terms, which constitute a specific indexing and classification system used by medical libraries and in databases.

Free textword searches

Searches using free textwords (keywords or phrases) can be made in most databases, but we will illustrate this with PubMed. Visit PubMed's home page **www.pubmed.gov** and enter one or more words in the query box at the top of the page. You can use small letters throughout. Click on GO, whereupon PubMed will combine your words automatically (AND is inserted automatically between the words). The number of hits is shown and you will be presented with a number of references. Most of the references in PubMed include an abstract of the article, which you can call up by clicking on the underlined names of the authors. Some articles are presented in their entirety and these can be called up by clicking on the name of the publisher immediately above the heading of the article. For most textwords PubMed will automatically link to a MeSH term (check by clicking on the *Details* function to confirm). PubMed (and also TRIP and Scirus databases) will sometimes suggest alternative search words.

Searching by textwords can be effective as long as you include all the various synonyms for your search (see p. 22).

Searching with MeSH

MeSH terms constitute a specific indexing and classification system consisting of controlled subject headings used to describe the contents of each article entered in MEDLINE. MeSH stands for *Medical Subject Headings* and is a kind of bibliographical dictionary or thesaurus used to enable computers to understand what you are looking for. There are about 22,000 MeSH terms in the system and you should use them to avoid missing relevant articles.

MeSH terms are classified in different subject groups and are arranged hierarchically, e.g.:

All MeSH Categories
  Diseases Category
    Cardiovascular Diseases
      Vascular Diseases
        Ischemia
          Myocardial Ischemia
            Myocardial Infarction
              Myocardial Stunning
                Shock, Cardiogenic

Thus *cardiovascular diseases* range higher up in the hierarchy than *myocardial infarction* so that a search on this word will usually also include *myocardial infarction.* PubMed automatically includes all MeSH terms that range below the MeSH term you have chosen (i.e. an *Explode* function is also included). Therefore, always check that your search word is a MeSH term, where it ranges in the hierarchy and if there is a MeSH term higher up in the hierarchy that may be even more useful. Go to PubMed's home page **www.pubmed.gov** and click on *MeSH Database* listed in the side bar. Enter a textword. If your textword is not a MeSH term, suggestions for such will be provided.

Combining terms and sets

After creating sets of citations that are pertinent to your topic you may want to combine two or more of these sets. If you want to use search words with similar meanings, you should combine them by typing, for instance, *smoking* OR *tobacco.* You will then be presented with articles that are indexed with either *smoking* or *tobacco.* This search strategy is called Boolean search (after its creator George Boole). The terms OR, AND and NOT have the following meanings:

Boolean operators				Meaning
OR:	Smoking		Tobacco	Retrieves articles with either word
AND:	Breast neoplasms		Risk factors	Retrieves articles with *both* words
NOT:	Breast neoplasms		Male cancer	Retrieves articles with some exclusion

Principal database search strategy

Under the search area (query box) in the upper portion of PubMed's start-ing page you will find the Features Bar with the following headings: *Limits, Preview/Index, History, Clipboard, Details.* The *Limits* function is described in more detail on p. 28, but here we shall take a closer look at the *Details* and *History* functions.

Details

This function shows how your search has been translated by PubMed's auto-matic term mapping of the *MeSH terms, Subheadings* and *Text Words* that have been used and how your search terms have been combined with AND, OR and NOT, respectively. When searching in PubMed, an automatic search is made for similar subject terms. After searching on heart attack, the *Details*

When you follow two separate chains of thought, Watson, you will find some intersection which should approximate to the truth.
Sherlock Holmes in *The Disappearance of Lady Frances Carfax.*

function will show *myocardial infarction [MeSH term]* OR *heart attack [Text Word]*. This means that the search on *heart attack* results in the automatic inclusion of the MeSH term *myocardial infarction.* Use *Details* any time you want to check how PubMed understood the search terms you entered.

History

PubMed will hold all your search strategies and results in *History.* It displays the search number, your search query and the number of citations in your results. To view the results from a search, click on the number of results.

The *History* function is very useful for combining several search terms. The general method for database searching is based on PICO (pp. 1–2) as follows:

P   AND   *I*   AND   *C*   AND   *O*

However, since each of the *P*, *I*, *C*, *O* parts may have several synonyms (typically two or three), each of the four parts need to be explored separately to obtain the maximum search outcome. Your search strategy should therefore be (assuming one synonym for each *P*, *I*, *C*, *O* part):

$(P_1 \text{ OR } P_2)$ AND $(I_1 \text{ OR } I_2)$ AND $(C_1 \text{ OR } C_2)$ AND $(O_1 \text{ OR } O_2)$

PubMed's *History* function is very useful for refining search strategies by adding one or more terms, one at a time. Click on *History* and do your search as follows:

Write	Command 1	PubMed Table will show: "Most recent Queries"	Command 2
Your P_1-word	PREVIEW	#1	CLEAR
Your P_2-word	PREVIEW	#2	CLEAR
All *P*s: #1 AND #2	PREVIEW	#3	CLEAR
Repeat procedure for all synonyms also for your I, C and O, yielding:			
All *I*s: #4 AND #5	PREVIEW	#6	CLEAR
All *C*s: # 7 AND #8	PREVIEW	#9	CLEAR
All *O*s: #10 AND #11	PREVIEW	#12	CLEAR

Finally, write: #3 AND #6 AND #9 AND #12, click on PREVIEW and the combined result of your search will be shown (=#13).

It is usually not necessary to include a search on C (Control) if, for instance, *RCT* is included in the search; as then, by definition, there must be a control group anyhow. Check with the *Details* function to see how your search was interpreted. Click on the hits result and the references you have found with your search will be shown. If your search has yielded 0 (nil) hits, it is probable that you have either made some mistake (e.g. misspelled), taken the process too far or, alternatively, there are no articles available on your query (which is highly unlikely). If you have obtained too many hits (more than 300–400) you may need to improve the specificity of your search (see p. 27).

EXAMPLE

Now we will do a broad search by choosing free textwords that are relevant to your subject. Let us return to the example (on p. 3) where Dr Mortimer wondered about the effect of vitamin E on the risk of dying of myocardial infarction. (As always, you will have first done a search in the Cochrane Library and found that no complete report is available, but a protocol was being developed [4].) You should now fill in the standard table with your own search terms. Use medical textwords of your own which you consider to be relevant to your question. Try to think of different words with similar meanings for each of your P, I ,C, O words, (e.g. cardiac arrest, cardiac asystole, cardiac standstill, coronary attack, heart arrest, myocardial necrosis).

Fill in clinical data in the standard table:

		P **Patient** **diagnosis/** **problem**	**I** **Intervention**	**C** **Control,** **standard**	**O** **Outcome**
F	**Step 1** Formulate a question	Your clinical data, queries	*65+ -year-old* *male, angina* *pectoris,* *myocardial* *infarction*	*Vitamins,* *vitamin E*	*No* *vitamins*	*New* *infarction,* *death*
I	**Step 2** Information search	Your own search words/ textwords MeSH terms	*Angina* *pectoris,* *myocardial* *infarction,* *heart attack,* *cardiac arrest,* *cardiac* *standstill, etc.*	*Vitamins,* *vitamin E,* *antioxidants,* *free radicals,* *oxidative* *stress,* *scavengers*	*Control,* *placebo*	*Death,* *mortality*
R	**Step 3** Review of information and critical appraisal					
E	**Step 4** Employ the results					

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The next step is to find appropriate MeSH terms (pp. 20–21).

Fill in the MeSH terms in the standard table:

		P **Patient** **diagnosis/** **Problem**	**I** **Intervention**	**C** **Control,** **standard**	**O** **Outcome**
F	**Step 1** Formulate a question	Your clinical data, queries	*65+ -year-old* *male, angina* *pectoris,* *myocardial* *infarction*	*Vitamins,* *vitamin E*	*No* *vitamins*	*New* *infarction,* *death*
I	**Step 2** Information search	Your own search words/ textwords	*Angina* *pectoris,* *myocardial* *infarction,* *heart attack,* *cardiac arrest,* *cardiac* *standstill, etc.*	*Vitamins,* *vitamin E,* *antioxidants,* *free radicals,* *oxidative* *stress,* *scavengers*	*Control,* *placebo*	*Death,* *mortality*
		MeSH terms	*Myocardial* *infarction,* *angina* *pectoris,* *arteriosclerosis*	*Vitamins,* *vitamin E,* *antioxidants,* *free radicals*	*Control,* *placebo*	*Death,* *mortality*
R	**Step 3** Review of information and critical appraisal				
E	**Step 4** Employ the results				

Determine what MeSH terms are higher up in the hierarchy by opening PubMed's home page via **www.pubmed.gov**. Click on *MeSH Database* in the blue side bar to the left on the starting page. Check the position of your particular MeSH terms in the hierarchy by entering them in the white box at the top. Here you can also get definitions of the terms and find alternative terms or similar concepts. For example, there is a reference to antioxidants for vitamin E. The following information will be presented.

MeSH term	MeSH term higher up in the hierarchy or referenced MeSH terms
Myocardial infarction	Cardiovascular diseases
Angina pectoris	Cardiovascular diseases
Arteriosclerosis	Cardiovascular diseases
Vitamin E	Antioxidants
Free radicals	Antioxidants
Oxidative stress	Antioxidants
Scavengers	Antioxidants
Death	Death
Mortality	Mortality

A search for the combination *cardiovascular disease* AND *antioxidants* AND (*death* OR *mortality*) results in over 1000 hits. Articles relevant to your query will probably be among them (good sensitivity), but the problem is that they will be concealed among many articles that you are not interested in (poor specificity).

Limit your search results/increase your specificity

Hopefully, you will now have retrieved articles that can answer your query (i.e. you have achieved good sensitivity). The next step will be to increase your search specificity by restricting your search by trying to exclude the articles you have retrieved but in which you are not interested. The terms AND or NOT increase the specificity of your search (p. 21).

Limits

Use PubMed's *Limits* function positioned in the Feature bar below the white query box. This function reduces the number of hits by allowing you to restrict your search. You can limit your search to a specific age group or gender, a specific language or to specific types of articles such as RCTs. The most useful restrictions in the *Limits* function are the following:

Limitation	Example
Publication types	Clinical trial
	Meta-analysis
	Practice Guideline
	Randomized controlled trial
	Review
Language	English
Human or animal	Human
Entrez date	5 years

It is an old maxim of mine that when you have excluded the impossible, whatever remains, however improbable, must be the truth.
Holmes in *The Adventure of the Beryl Coronet.*

SLIM

A recent development in PubMed is the alternative Web interface SLIM (Slider Interface for MEDLINE/PubMed searches). SLIM uses five different interactive slider bars to control various search parameters such as limits, filters and MeSH terminologies. SLIM is intended to improve user control and the capability to instantly refine and refocus search strategies [5]. **http://pmi.nlm.nih.gov/slide**

Useful suffixes in PubMed (Note: You must use square brackets):

Suffix	Meaning	Example
[au]	Author	Smith [au]
[ta]	Journal title abbreviation	Lancet [ta]
[mh]	MeSH term	breast neoplasms [mh]
[pt]	Publication type	review [pt]
[tw]	Textword (word in title of article or abstract)	breast cancer [tw]
[ti]	Title (word in title of article)	risk factor [ti]
[sb]	MeSH Subheadings (describes a particular aspect of a subject)	therapeutic use [sb]
*	Truncation (searches for main stem of word)	staph*
" "	Quotation marks (search for exact search term)	"health planning"
( )	Connects words	hyperparathyroidism NOT (renal OR secondary)

Useful MeSH terms when searching for therapy studies, diagnostic tests, systematic reviews / meta-analyses and Clinical Practice Guidelines, respectively:

	Useful MeSH terms
Therapy studies	Randomized controlled trial [pt]
	Controlled clinical trial [pt]
	Clinical trial [pt]
	Meta-analysis [pt]
	Random [tw]
	Random* [ta]
	Placebo
	Prognosis
	Therapeutic use [sb]
	Morbidity
	Mortality
Diagnostic tests	Sensitivity [tw]
	Specificity [tw]
	Predictive value [tw]
	Likelihood functions
	Diagnosis, differential
Systematic reviews/meta-analysis	Review [pt]
	Meta-analysis [pt]
	Odds ratio – prognosis
	Systematic [sb]
	Morbidity
	Mortality
Clinical Practice Guidelines	Guidelines [tw]
	Guideline* [tw]
	Practice guideline
	Guide [tw]
	Recommend* [tw]

EXAMPLE

Now if we return to the example (on p. 3 and p. 25ff.) and Dr Mortimer's query about the effect of antioxidants on cardiovascular disease, the result of a PubMed search (displayed in the *History* function) will be as follows:

Search term	Number of hits
Cardiovascular diseases (#1)	>1 million
Antioxidants (#2)	>100,000
Death OR mortality (#3)	>600,000
#1 AND #2 AND #3	>1000

It seems that a search covering cardiovascular diseases, antioxidants, death and mortality has the prerequisites for yielding many hits with high sensitivity. But the specificity needs to be increased. Using study-type specific MeSH terms can do this.

Randomized controlled trial (#4)	>200,000
Meta-analysis (#5)	>14,000

You can then combine the above search terms by writing #1 AND #2, etc. in the search box:

Combined search words	Number of hits
#1 AND #2	>9000
#1 AND #2 AND #3	>1000
#1 AND #2 AND #3 AND #4	239
#1 AND #2 AND #3 AND #5	27

Thus, by combining the MeSH terms *cardiovascular diseases* AND *antioxidants* AND (*death* OR *mortality*) AND *meta-analysis* as search words, you have come down from over 1 million hits to 27 articles.

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On examining these 27 hits, we find the article by Vivekananthan et al., Use of antioxidant vitamins for the prevention of cardiovascular disease: meta-analysis of randomized trials [6]. This study summarizes 12 large trials in which over 130,000 patients were studied. The conclusion drawn from the study is that vitamin E has no positive effect on cardiovascular mortality and that beta-carotene actually increases the mortality. Thus, this meta-analysis arrived at an entirely different conclusion than that presented by the commercial Website ("Vitamin E can reduce the risk of dying of myocardial infarction by 77%").

(You should also take a look at the articles retrieved ($n = 239$) with the combination #1 AND #2 AND #3 AND #4. There may be articles here that are of interest.)

Use a good hit for further searches

The next step in the search procedure is to look through the articles you have retrieved, select a relevant one and use it to find other articles of interest. Let's continue with PubMed.

Related Articles

Once you have found an article that is relevant, click on the Related Articles function to the right of the article. The function yields hits on articles that are indexed similarly to the article you have identified. In our example, we get more than 100 such Related Articles proceeding from the article by Vivekananthan et al. [6].

It may also be a good idea to check the MeSH terms with which the retrieved article is indexed: Go to the Display function and select the Citation format and you will be presented with the MeSH [mh] terms with which the identified article was indexed. You can use these MeSH terms to find similar articles.

Once you have found an article of interest, you can check out the summary (abstract) by clicking on the underscored line showing the name of the author. Some journals offer direct access to the whole article in PubMed (e.g. BMJ) so you can read it immediately or print it out (preferably in the PDF format). The university libraries subscribe to a large number of electronic versions of journals and thereby enable you to make printouts of many of the articles you have found.

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The ideal reasoner would, when he had once been shown a single fact in all its bearings, deduce from it, not only all the chains of events which led up to it, but also all the results which would follow from it.
Sherlock Holmes in *The Five Orange Pips.*