

1 **Putting the “systematic” into searching – tips for search strategies in**
2 **systematic reviews**

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24 **Putting the “systematic” into searching – tips and resources for search**
25 **strategies in systematic reviews**

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27 The quality of the methodology of published systematic reviews in hand surgery is highly
28 variable. This is especially the case with the proliferation of non-Cochrane Reviews in
29 recent years. There are many potential deficiencies in systematic review methods which
30 can lead to a risk of bias or erroneous conclusions (Garcia-Doval et al., 2017).

31 A fundamental aspect is the quality of the literature search strategies employed. Some
32 published systematic reviews in hand surgery have search strategies that are simplistic,
33 omit relevant terms, or contain basic syntax errors, while some do not search a
34 comprehensive range of databases. In some cases the search strategy is not even
35 documented adequately or at all, despite the requirements of the PRISMA (Preferred
36 Reporting Items for Systematic Reviews and Meta-Analyses) reporting guideline (Moher
37 et al., 2009). This means the search strategy cannot be checked and reproduced (a key
38 indicator of quality). A poor search can lead to the omission of relevant studies, with a
39 potentially significant impact on any subsequent analysis and the conclusions reached.

40 In this article we aim to provide helpful tips for systematic review authors to avoid
41 common errors and optimise their search strategies. The article should also help readers
42 to critically appraise and interpret existing reviews. It is not intended as a
43 comprehensive guide to systematic searching. Detailed advice on searching for studies is
44 available online in the *Cochrane Handbook for Systematic Reviews of Interventions*
45 (Lefebvre et al., 2011).

46 It takes time and expert training to learn how to compile a comprehensive and sensitive
47 search strategy, and there are many pitfalls for the unwary. We suggest that it is always
48 best to attend a systematic review training course to learn from experts before starting.

49

50 **Choice of databases to search**

51 Ideally, any systematic review should search more than one database to maximise the
52 likelihood of finding all relevant studies. We would suggest a combination of MEDLINE
53 (<https://www.nlm.nih.gov/bsd/pmresources.html>), Embase
54 (<https://www.elsevier.com/en-gb/solutions/embase-biomedical-research>), and Cochrane
55 CENTRAL (<http://www.cochranelibrary.com/about/central-landing-page.html>) as a
56 minimum for a systematic review on interventions. This combination was also suggested
57 by Le Cleach et al. (2016).

58 There is sometimes confusion by systematic review authors about the difference
59 between bibliographic databases and search interfaces. Several databases are available
60 through more than one search interface, with each interface having its own search
61 commands and syntax. An interface that is widely used in systematic reviews is Ovid
62 (<http://www.ovid.com>). Ovid is particularly suited to building up systematic searches
63 term by term, and can be used to search multiple databases. Examples of alternative
64 interfaces include Ovid MEDLINE or PubMed, and Ovid Embase or Embase.com. If the
65 free interface PubMed (<https://www.ncbi.nlm.nih.gov/pubmed>) is used to search
66 MEDLINE, this should be stated, as PubMed includes some content in addition to
67 MEDLINE. In particular PubMed has a collection of open-access journals in PubMed
68 Central (PMC), not all of which are indexed for MEDLINE.

69 Often MEDLINE or PubMed are the only databases searched in hand surgery systematic
70 reviews. However, they do not include all refereed medical journals, so there is potential
71 to miss relevant studies. For this reason we suggest combining MEDLINE or PubMed with
72 Embase, as there are over 2,900 indexed journals unique to Embase
73 (<https://www.elsevier.com/en-gb/solutions/embase-biomedical-research>), including
74 journals from Eastern Europe and Asia. Embase also includes conference abstracts,
75 whereas MEDLINE and PubMed do not, so authors may want to consider this if a review
76 is to include more than full text articles.

77 CENTRAL is a comprehensive database of randomised controlled trials compiled from
78 individual Cochrane Group trial registers, hand searching and regular database searches.
79 It includes unpublished trials and trial reports that are not included in MEDLINE, PubMed
80 nor Embase, hence the recommendation it is included in searches on interventions.

81 Finally, depending on the topic of the systematic review, it may be appropriate to include
82 other, more specialised databases in addition to the three suggested above. Suggestions
83 for relevant databases in different topic areas are shown in Table 1.

84

85 **Identifying search concepts**

86 A systematic search strategy is constructed by defining the search concepts on the basis
87 of a carefully constructed research question. It helps the reader if the report of a
88 systematic review specifically states the research question and the search concepts
89 involved—these are not always clear in published systematic reviews.

90 It is common to use a “PICO” question for reviews of interventions and a “PEO” question
91 for a review of risk factors, such as comorbidities etc. In a PICO question, the search
92 concept P stands for patient or population, I for intervention, C for comparator and O for

93 outcome. An example PICO question would be the efficacy and safety of endoscopic
94 release versus conventional surgery for patients with carpal tunnel syndrome. In a PEO
95 question, P stands for patient or population, E for exposure and O for outcome. An
96 example PEO question would be the association between Dupuytren’s disease in adults
97 and diabetes mellitus.

98 However, PICO and PEO are only guides in identifying the search concepts—authors
99 should think carefully about what defines the studies of interest in constructing their
100 search strategy. Generally it is desirable to keep the number of search concepts to be
101 combined to a minimum to avoid excluding a relevant study, although this has to be
102 balanced against the risk of getting too many search results to handle. The outcome O is
103 an essential component of PEO questions and needs to be included in the search
104 strategy. However, the outcome O is often omitted in the search strategy for PICO
105 questions, as it can be difficult to define a comprehensive list of outcome terms, and the
106 outcomes may not actually be mentioned in the title or abstract.

107 It helps to look at the strategies used for similar systematic reviews, especially if there is
108 indication that an information specialist was involved in compiling the search. In the
109 Cochrane Library (<http://www.cochranelibrary.com>) expert search strategies are
110 available in both published Cochrane Reviews and Cochrane Review Protocols.

111

112 **Constructing search strategies**

113 The next step is to compile a comprehensive list of alternative terms or synonyms for
114 each search concept. These alternative terms are combined in the search strategy with
115 the Boolean operator OR. Boolean operators (or terms) are used to define the logic of
116 relationships between sets. The search concepts are then combined using the Boolean
117 operator AND. This identifies those records in the database that include all the search
118 concepts in the search strategy.

119 The basic type of search terms most people are familiar with, e.g. when searching
120 Google, is a “free text” search term. A free text term searches for a word (or words) in
121 the different fields of the database records, *regardless of the word’s meaning*. Hence,
122 non-relevant articles will inevitably be retrieved for free text terms with multiple
123 meanings. Examples of such terms include radius (the bone or radius of a circle), nails
124 (of the fingers or metal nails), palm (hand or tree) and digital (finger or technology).
125 Free text terms also retrieve articles regardless of their topic. Thus, a study whose
126 abstract stated it included adults but not children would be found in a search for
127 paediatric studies using the free text term “children”.

128 For maximum sensitivity, a search strategy should also include "subject headings", if
129 these are used by the bibliographic database. Subject headings are fixed terms for a
130 given topic. Subject headings are derived from a thesaurus and are usually arranged in a
131 hierarchy or tree structure. They are added to database records by the database
132 producer when they are "indexed", on the basis of a subject analysis. In other words,
133 they indicate what the article is *about*. Subject headings get round the problem of
134 alternative terms and spellings (e.g. US and UK English) for the same topic. They may
135 retrieve a relevant article when the fields in the database record do not include any of
136 the expected free text terms. The best known subject headings are MeSH terms (Medical
137 Subject Headings), as used in PubMed, MEDLINE and the Cochrane Library. Embase has
138 its own, separate set of subject headings called Emtree terms.

139 The appropriate subject headings for a search concept can be identified in a variety of
140 ways. Some search interfaces, such as Ovid and the Cochrane Library, have built-in tools
141 ways to allow users to map entered terms to possible subject headings and then add
142 them to their search. PubMed has automatic mapping to subject headings, which appear
143 in the "Search details" box on the lower right of the PubMed results screen. However,
144 this automated mapping depends on the correct interpretation of the meaning of the
145 entered term and can be unpredictable, so should not be relied on in a systematic
146 search. It is best to identify the relevant MeSH terms using the online MeSH browser
147 (<https://meshb.nlm.nih.gov/search>), and then add them to a PubMed search strategy
148 with the appropriate search command, for example "metacarpal bones"[MeSH Terms].

149 To avoid missing any relevant studies, it is important to take time to think about what
150 terms might be used in the titles and abstracts of relevant studies, and to include all the
151 possible free text terms for each search concept. Textbooks, web resources, relevant
152 journal articles and published systematic review search strategies are all potential
153 sources to identify relevant terms.

154 A good start is to consider the following:

- 155 1. Singular and plural terms (e.g. finger, fingers; phalanx, phalanges, phalanxes;
156 junctura tendinum, juncturae tendinum)
- 157 2. Synonyms and abbreviations (e.g. scaphotrapeziotrapezoidal, triscaphe,
158 triscaphoid, STT; triangular fibrocartilage, triangular cartilage, triangular
159 fibrocartilaginous, TFCC; thromboangiitis obliterans, Buerger's disease)
- 160 3. Alternative spellings, especially UK and US English (e.g. anaesthesia, anesthesia;
161 ischaemic, ischemic; haematoma, hematoma)
- 162 4. English and Latin terms (e.g. posterior tibial tendon, tibialis posterior tendon)

- 163 5. Permutations of terms (e.g. pronator {teres} syndrome; supinator
164 {tunnel/entrapment} syndrome)
- 165 6. Hyphenated and non-hyphenated terms (e.g. radioulnar, radio-ulnar;
166 peripisiform, peri-pisiform)
- 167 7. Separated and conjoined terms (e.g. opponens plasty, opponensplasty; clubhand,
168 club hand; swan-neck, swan neck, swanneck)
- 169 8. Possessives (e.g. Bier's, Biers, Bier; Dupuytren's, Dupuytren's, Dupuytren)

170 For strings or phrases, i.e. two or more words together, keep them as short as possible
171 and look for words in common when various permutations occur. Often a single common
172 word will do. For example, the single term "supinator" may suffice for "supinator tunnel
173 syndrome" and "supinator entrapment syndrome". When searching PubMed, strings
174 should be put in inverted commas (e.g. "ganglion cyst", "radial styloidectomy").
175 Otherwise PubMed will automatically combine the two terms using AND, rather than
176 searching for the two words occurring together in the specified order, giving additional,
177 extraneous results.

178 As a final point, search strategies can easily be compiled as a single line strategy, with
179 parentheses around the terms for each of the search concepts to ensure the correct logic
180 of the Boolean operators. This approach is particularly suited to PubMed. Alternatively, in
181 interfaces such as OVID, it is possible to build up search strategies line by line and
182 subsequently combine lines with the appropriate Boolean operators.

183

184 **Methodology filters for different study designs**

185 Methodology filters to search for specific study designs are available for various
186 databases and can be incorporated as part of a search strategy. Examples include filters
187 for randomised controlled trials, observational studies and diagnostic studies. It is
188 perhaps best to avoid using such filters as part of a formal systematic search strategy,
189 as they inevitably bring a risk of missing relevant studies. However, filters may be
190 essential if there would otherwise be too many search results to handle. If filters are
191 used, ideally they should be highly sensitive and validated. A useful list of filters which
192 can be referenced has been compiled by the InterTASC Information Specialists' Sub-
193 Group:

194 <https://sites.google.com/a/york.ac.uk/issg-search-filters-resource/home>

195

196 **Reporting search strategies**

197 For purposes of transparency and repeatability, there should be enough information in
198 the report of a systematic review to allow someone else to replicate the search and
199 identify the same studies. The PRISMA Statement (Moher et al., 2009) indicates that a
200 full electronic search strategy for at least one database should be given. This tends to be
201 PubMed or Ovid MEDLINE, as they are best known. Usually the search strategy is
202 provided in an appendix.

203 According to PRISMA, the date last searched should be recorded. As indicated earlier, it
204 is also important to specify the search interface/supplier as well as the database name,
205 as this affects the search commands that have to be used and the currency of the
206 database on a given date.

207

208 **Finally—involve an information specialist...**

209 Key tips from this article for search strategies in systematic reviews are listed in Table 2.

210 There is no doubt that, with training and experience, clinical researchers can understand
211 and avoid the common pitfalls and learn to be proficient searchers. However, in this age
212 of specialism and rising standards, the ideal approach is to involve an expert—an
213 information specialist or medical librarian with good experience of database searching for
214 systematic reviews. Their expertise can be combined with your exact knowledge of the
215 clinical research question and technical terms, for optimal results.

216 One of the key advantages of Cochrane Reviews is that Cochrane Group information
217 specialists compile and/or check the search strategy, and are also involved in the peer
218 review process. It has been demonstrated that involvement of librarians and information
219 specialists improves the quality of the search strategies in systematic reviews
220 (Rethlefsen et al. 2015). So the best advice is to seek out help from an expert searcher.
221 You will learn a lot and produce a more reliable and useful systematic review as a result,
222 and may also be one step closer to getting it published!

223

224 **Extended resources**

225 The Centre for Evidence Based Hand Surgery (CEBHS) has launched an open-access
226 source of citations for systematic reviews relevant to hand surgery and therapy. This
227 database offers a “one-stop” easy way to find systematic reviews. There are two free
228 resources.

229 (1) **HandSRev**, a database and mapping of systematic reviews by topic that is
230 updated monthly:
231 <https://www.nottingham.ac.uk/research/groups/cebhs/handsrev/index.aspx>. (2) **Hand**
232 **Surgery Evidence Updates**, free monthly e-mails that list and summarise new
233 guidelines and systematic reviews as they are published:
234 <https://www.nottingham.ac.uk/research/groups/cebhs/evidence-updates/index.aspx>.
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260 Table 1. Suggested bibliographic databases for specialised topics relevant to hand
261 surgery. Some of these databases are available through more than one search interface.

262

Topic	Database
Psychological or quality of life aspects	PsycINFO http://www.apa.org/pubs/databases/psycinfo/index.aspx
Physiotherapy	PEDro https://www.pedro.org.au
Sport	SPORTDiscus https://www.ebsco.com/products/research-databases/sportdiscus Physical Education Index http://www.proquest.com/products-services/pei-set-c.html
Nursing	CINAHL https://health.ebsco.com/products/the-cinahl-database
Allied and complementary medicine	AMED https://www.ebsco.com/products/research-databases/amed-the-allied-and-complementary-medicine-database
Basic science, technology or engineering	Web of Science http://wokinfo.com Scopus https://www.scopus.com/

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265

<i>Searching:</i>
(1) Use a combination of the databases MEDLINE, Embase and Cochrane CENTRAL as a recommended minimum for a systematic review on interventions.
(2) Consider adding in other, more specialised databases, or a general scientific database (Web of Science or Scopus), according to the topic of the review.
(3) Clearly identify the research question and the search concepts involved using the PICO or PEO format.
(4) Identify all possible free text terms for each search concept, using textbooks, web resources, journal articles and published search strategies as potential sources.
(5) Include the appropriate subject headings as well as free text terms.
(6) Keep strings or combinations of words as short as possible, and choose words in common when various permutations occur.
(7) In compiling alternative free text terms consider: Singular and plural terms; synonyms and abbreviations; alternative spellings (especially UK and US English); English and Latin terms; permutations of terms; hyphenated and non-hyphenated terms; separated and conjoined terms; possessives.
<i>Reporting:</i>
(1) Provide enough information in the report of a systematic review to allow someone else to replicate the search and find the same studies, including an example search strategy as specified in the PRISMA Statement.
(2) Report the date last searched, and specify which interface was used if a database is available from more than one supplier.