HOW TO CONDUCT A RIGOROUS DATABASE SEARCH IN 10 STEPS

Kate Reynolds

Dan Isaak

Heather Woods

Kathy Stodart

Patricia McClunie-Trust

About the authors: *Kate Reynolds, BA(Hons), MLIS, RLIANZA, is the liaison librarian at Wintec/ Te Pūkenga, Hamilton, New Zealand.*

Dan Isaak, RN, PGDip, works as a staff nurse in the intensive care unit, Wellington Hospital.

Heather Woods, PGDip ILS, is the librarian and records manager at the New Zealand Nurses Organisation, Wellington.

Kathy Stodart is a journalist and production editor at Kaitiaki Nursing Research.

Patricia McClunie-Trust, RN, PhD, is a principal academic staff member at Wintec/Te Pūkenga, Hamilton. Her correspondence address is: patricia.mcclunie-trust@wintec.ac.nz

Introduction

INTERNATIONAL HEALTH databases hold a vast array of information for nursing. But a nurse researcher cannot access and use this wealth unless they know how to conduct an advanced database search. To bring together the best quality and spread of data for a research project, a search must be rigorous, and both narrow enough to exclude what is not relevant, and wide enough to capture a spread of results to eliminate bias. The level of rigour is important if a researcher is going to make claims based on a review of the literature. For nurses studying at master's level, there is now an increasing expectation that their academic work should include details of how they conducted their literature searches to show their understanding of the search process. Lecturers teaching postgraduate nursing students are involved in coaching emerging researchers in more advanced search skills. Librarian Kate Reynolds and nursing academic Patricia McClunie-Trust have worked with publisher representatives to develop database search strategies for postgraduate students undertaking their first in-depth evidence review. In this article they describe how to go about an advanced search, using the example of a research project being conducted by registered nurse Dan Isaak.

Evidence reviews

Clinical decision-making and the development of clinical guidelines are informed by robust summaries of evidence. These summaries are developed using various methods, such as systematic reviews, meta-analyses, and qualitative evidence synthesis (Moher et al., 2015). The process used to conduct a database search affects the overall quality of evidence synthesis (Eriksen et al., 2018) because it is important to find and synthesise all evidence that is relevant to the review question. However, there is also a need to balance a comprehensive search with inclusion and exclusion criteria that will select only those studies that are relevant (Gusenbauer & Haddaway, 2020). Minimising the risk of error and bias by following rigorous methods is what differentiates systematic reviews and evidence syntheses from other reviews of the literature (Aromataris & Munn, 2020).

The identification of evidence requires the application of the right strategy in the right search systems (Gusenbauer & Haddaway, 2020), along with a clearly defined systematic search process (Moher et al., 2015). Well-ordered approaches to literature searching, based on predefined criteria, are key to finding appropriate research as evidence for practice. Finding a balance between making a database search specific, and yet sensitive enough to find appropriate studies for inclusion in a review, can be challenging (Bramer et al., 2018). However, the search process for a systematic review should be transparent, informing the reader why certain studies were included or excluded from the review. As information specialists, librarians are important guides for researchers seeking to understand how to construct a specific search strategy across selected databases (Cooper et al., 2018). Cooper et al. note that missing relevant studies could introduce bias into the review results, including exaggerating

the effect of an intervention study. However, there is some debate in the literature about the scope of literature searches, particularly in relation to qualitative reviews, where the quality of primary studies may be more important than the quantity.

The search process in published evidence reviews generally includes three phases, including developing the concepts and search process with a librarian, conducting the search across appropriate databases for the topic of the review, and finally undertaking a "hand search" of the references included in the studies selected for the review. Bramer et al. (2018) set out 10 steps to work through to create and conduct a systematic search, to underpin the three phases reported in systematic reviews. Here, we use an example of a search conducted for a meta-synthesis, using meta-ethnography as the methodological approach.

Step 1. Identify a focused question.

The search strategy builds on the review question, which should be formulated according to the type of research sought for the review. Dan Isaak, a registered nurse (RN) in the intensive care unit (ICU) at Wellington Hospital, wanted to understand more about nurses' experiences of providing end-of-life care in the ICU. Therefore, the question for his review was simply stated as: *What are registered nurses' lived experiences of end-of-life care in the ICU?*

Step 2. Distinguish the type of articles or primary research reports that can answer the question.

The aim of this review was to understand how RNs experience working with patients and families in end-of-life care situations, so Dan sought qualitative primary research that included rich participant voices sharing participants' feelings, emotional responses and understanding of their experience, to answer his question.

Step 3. Decide which key concepts define the different elements of the question.

The PICO format is the most common approach to framing a review question, usually structured as **P**opulation, **I**ntervention or exposure, **C**omparison intervention or exposure, and the clinical **O**utcome or interest (Eriksen & Frandsen, 2018). However, as Munn et al. (2018) note, it is important to also consider questions that take a broader approach to what counts as evidence for evidence-based care. This review required an experiential and qualitative approach to investigate the meaningfulness of experiences related to a phenomenon of interest, so the PICo for Dan's question was framed as **P**opulation, phenomenon of **I**nterest, and **Co**ntext.

Step 4. Identify which elements of these concepts should be used to locate the best results.

Table 1, below, sets out the PICo structure that was used to frame the search for primary qualitative research on RNs' lived experiences of end-of-life care in the ICU.

The population for this search was RNs, without any limits on gender, age, ethnicity or country of publication for primary research. The experiences of patients, families, health-care assistants or nurses with other levels of registration were excluded. The phenomenon of interest was RNs' experiences of caring for patients in end-of-life care situations. End-of-life care was defined as holistic support provided to people and their families when death is imminent. The term "palliative care" was excluded from the search because it occurs in a different context, with a defined philosophy of care in the community. Primary research with rich participant descriptions was sought to illuminate RNs' feelings, emotions and perceptions of end-of-life care. The context was end-of-life care for adults in the ICU, and other intensive-care contexts, such as the neonatal intensive care unit (NICU) and paediatric intensive care unit (PICU) were excluded. The inclusion timeframe for primary research was since 2010, to find studies reflecting contemporary practice.

Step 5. Choose an appropriate database to trial the search.

Database search systems need to effectively find relevant information while filtering out what is not relevant, enabling rapid identification and retrieval of records. The search methods should enable the same search to be reproduced using the same methods (Gusenbauer & Haddaway, 2020). Gusenbauer and Haddaway recommend 16 potential databases to use as the principal approach to refine the search process. PubMed and CINAHL are two of the databases listed which we recommend to our students, as they are specialised and yet multidisciplinary across the health sciences. Furthermore, their search interface supports systematic searching and enables the researcher to have a high level of control over the scope and focus of the search. CINAHL and PubMed have a controlled vocabulary to

Table 1. PICo structure

PICo	Concepts	Additional key words
Population	Nurses	Registered nurses, RNs
Phenomenon of **I**nterest	End-of-life care Experience	Death, dying Lived experience, attitude perceptions, emotions, needs
Context	ICU	Intensive care units, acute care
Exclusion	Patients, family, NICU, PICU, child, paediatric, palliative, pre 2010, quantitative	

draw on to identify search terms, and the search can be developed using Boolean operators and field tags, and a range of further filters can be applied.

Steps 6 - 9. Document the search process, select index terms from the first database, identify synonyms from the database thesaurus or identify MeSH terms, and include variations in the spelling of search terms including abbreviations, truncations and Boolean terms.

Librarians can use their knowledge of databases, information sources and search strategies to both teach systematic search skills and help with the search itself. Librarian involvement in the search process will result in more thorough and replicable searches of a greater range of databases and information sources (Vasser et al., 2017). Librarians can assist in each of the systematic review steps, from formulating the problem to the assessment of study quality, as well as locating, selecting, and managing resources (Harris, 2005). Including information professionals, such as librarians, in a search process can result in a higher quality of evidence synthesis (Vasser et al., 2017). In this search, the librarian helped with the selection of keywords and controlled vocabulary, recommended relevant databases to search and provided advice on the formulation of search strings.

The formulation of search strings requires knowledge of a range of precision searching techniques, such as the Boolean operators AND, OR and NOT; field tags; truncation; phrase searching; and controlled vocabulary. In the search strings shown in Table 2 (below) and Table 3 (page 45), AND was used to *narrow* the search by combining all the search terms together, while OR was used to *expand* the search to include a range of related keywords and to search Title, Abstract and Main Heading (controlled vocabulary). Truncation was used by searching Nurs* to include all words built on this word stem, and quotation marks were used to create phrase searches on all phrases

Table 2. CINAHL search strings

Search #	Field tag	Key words
1	Title OR Abstract	Nurs* OR "registered nurse" OR RN
2	Main heading (MH)	Nurses OR "Registered Nurses" OR "Nurses, other"
3		S1 OR S2 *[Remember to CLEAR search]*
4	Title OR Abstract	"End-of-life care" OR Death OR Dying OR "Attitude to death" OR "terminally ill"
5	Main heading (MH)	"Attitude to Death" OR "Terminally ill Patients" OR Death
6		S4 OR S5 *[Remember to CLEAR search]*
7	Title OR Abstract	Experience OR "Lived experience" OR "Life experience" OR attitude OR perception OR emotions
8	Main heading (MH)	"life experience" OR attitude OR emotions
9		S7 OR S8 *[Remember to CLEAR search]*
10	Title OR Abstract	"Intensive care units" OR ICU
11	Main heading (MH)	"Intensive care units"
12		S10 OR S11 *[Remember to CLEAR search]*
13		S3 AND S6 AND S9 AND S12
	Filters	Since 2010, remove full-text limiter (on each search, relevant to our library as we have it set as default)
	NOT	NICU OR PICU OR child* OR paediatric OR neonatal OR infant OR adolescent

Table 3. Search history adapted from CINAHL record, showing search strings, search limiters and results

Search #	Search terms	Search options	Results
S1	TI (Nurs* OR "registered nurse" OR RN) OR AB (Nurs* OR "registered nurse" OR RN)	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(621,930)
S2	MH Nurses OR "Registered Nurses" OR "Nurses, other"	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(108,060)
S3	S1 OR S2	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(660,044)
S4	TI ("End-of-life care" OR Death OR Dying OR "Attitude to Death" OR "Terminally ill Patients") OR AB ("End-of-life care" OR Death OR Dying OR "Attitude to Death" OR "Terminally ill Patients")	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(232,544)
S5	MH "Attitude to death" OR "Terminally ill Patients" OR Death `	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(259,261)
S6	S4 OR S5	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(272,275)
S7	TI (Experience OR "Lived experience" OR "Life experience" OR attitude OR perception OR emotions) OR AB (Experience OR "Lived experience" OR "Life experience" OR attitude OR perception OR emotions)	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(599,505)
S8	MH "life experience" OR attitude OR emotions	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(60,364)
S9	S7 OR S8	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(628,752)
S10	TI ("Intensive care units" OR ICU) OR AB ("Intensive care units" OR ICU)	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(46,999)
S11	MH "Intensive care units"	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(44,208)
S12	S10 OR S11	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(69,042)
S13	S3 AND S6 AND S9 AND S12	**Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(568)
S14	S3 AND S6 AND S9 AND S12	**Limiters** – Published Date 20100101-20221231 **Expanders** – Apply equivalent subjects **Search modes** – Find all my search terms	(436)

of two or more words to search those terms as a single phrase. Controlled vocabulary terms (CINAHL subject headings) were searched separately and then combined with free text keywords to add a further level of precision to the search. Controlled vocabulary can be used to find " 'all and only' on a topic", "when you need extreme precision" and when "you need a unified approach to the different author voices" (Brown & Bell, 2018, pp. 74-75). Table 3 (above) shows the search steps, strings and results from the search. It should be noted that the final search demonstrated in Table 3 is the result of numerous prior searches of a range of databases and search systems that were used to determine the best search terms to use. The researcher must be prepared to constantly improve and update their search as their investigations within the various databases reveal other search variations.

Documenting the search process provides a systematic guide to work through, and makes the search replicable – that is, able to be repeated by another researcher (Gusenbauer & Haddaway, 2020). The use of a table allows the researcher to set out their search terms and strategy to match the functions of individual databases. It also makes it easy to follow the systematic search steps, to easily see

which field tags to use for each step, and the keywords are ready to be copied and pasted into a search bar. The example in Table 2 also has practical reminders to follow (in CINAHL, the researcher must remember to clear their previous search terms before combining one search with another) and also has the Boolean operators in capitals as this is required in some databases, so it is a good habit to follow. Further to this, the researcher may also like to incorporate the field tags specific to each database into the keyword search string, to allow them to copy and paste it directly into the search bar without having to also adjust drop-down menus. By structuring their search for each database in a table before conducting the search, the researcher is easily able to see the steps required by the idiosyncrasies of each database. It also makes the search easily replicable by another researcher and assists those checking the rigour of the search. Table 2 shows one way a researcher may set out their initial search strategy for each database.

Step 10. Map the individual database search strategies in a table

Table 3 sets out a record of the search history for the search in CINAHL, showing each of the search strings, search limiters and results.

Once the search process is complete, the records found are ready to be uploaded into reference management software, such as Endnote or Zotero. The records can then be saved into an evidence synthesis management site, such as Covidence or RevMan. These sites enable streamlined screening and selection of relevant studies according to the inclusion criteria set for the review.

Conclusions

Access to the most relevant information is essential to transfer the findings of the latest research into practice. While international databases have a wealth of knowledge, finding relevant published research studies can be daunting and confusing for emerging researchers without the support of an experienced librarian. This example of an ordered and systematic advanced search process reflects the current capability of our library databases. However, this is a rapidly developing field that requires researchers to work with librarians to constantly update their knowledge and skill in conducting searches.

References

Aromataris, E., & Munn, Z. (2020). JBI systematic reviews. In E. Aromataris & Z. Munn (Eds.), *JBI manual for evidence synthesis.* JBI. https://doi.org/10.46658/JBIMES-20-02

Bramer, W. M., De Jonge, G. B., Rethlefsen, M. L., Mast, F., & Kleijnen, J. (2018). A systematic approach to searching: An efficient and complete method to develop literature searches. *Journal of the Medical Library Association: JMLA, 106*(4), 531. https://doi.org/10.5195%2Fjmla.2018.283

Brown, C. C., & Bell, S. S. (2018). *Librarian's guide to online searching* (5th ed.). Libraries Unlimited.

Cooper, C., Booth, A., Varley-Campbell, J., Britten, N., & Garside, R. (2018). Defining the process to literature searching in systematic reviews: A literature review of guidance and supporting studies. *BMC Medical Research Methodology, 18*(1), 1-14. https://doi.org/10.1186/s12874-018-0545-3

Eriksen, M. B., & Frandsen, T. F. (2018). The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: A systematic review. *Journal of the Medical Library Association: JMLA, 106*(4), 420. https://doi.org/10.5195%2Fjmla.2018.345

Gusenbauer, M., & Haddaway, N. R. (2020). Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. *Research Synthesis Methods, 11*(2), 181-217. https://doi.org/10.1002/jrsm.1378

Harris, M. R. (2005). The librarian's roles in the systematic review process: A case study. *Journal of the Medical Library Association, 93*(1), 81-87. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC545126/

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Pettcrew, M., Shekelle, P., Stewart, L. & PRISMA-P Group. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews, 4,* Article 1. https://doi.org/10.1186/2046-4053-4-1

Munn, Z., Stern, C., Aromataris, E., Lockwood, C., & Jordan, Z. (2018). What kind of systematic review should I conduct? A proposed typology and guidance for systematic reviewers in the medical and health sciences. *BMC Medical Research Methodology, 18*(5). https://doi.org/10.1186/s12874-017-0468-4

Vassar, M., Yerokhin, V., Sinnett, P. M., Weiher, M., Muckelrath, H., Carr, B., Varney, L., & Cook, G. (2017). Database selection in systematic reviews: An insight through clinical neurology. *Health Information & Libraries Journal, 34*(2), 156. https://doi.org/10.1111/hir.12176