An evidence map is an overview of a broad research field that describes the volume, nature, and characteristics of research in that field [1]. Evidence maps can indicate research links, gaps, and strengths in a broad clinical context, while systematic reviews focus on a single clinical question [2, 3]. Maps complement systematic reviews by engaging stakeholders to identify and prioritize questions that may be informed by research evidence, highlighting the applicability of research evidence to different populations and contexts, and identifying important gaps that can inform further primary research or systematic reviews [3].

Evidence mapping can be a labor-intensive process, as it must provide an overview of the nature and characteristics of all research in any given field (Figure 1, online only). There are many more potentially useful references to review when mapping a topic area than when answering a specific clinical question, as in a systematic review. The searching challenges for evidence mapping are similar to those of a rapid review, which also needs to produce high-quality evidence with reduced resources. In the case of the rapid review, the time needed is limited [4].

The Global Evidence Mapping (GEM) Initiative was funded in 2007 by the Victorian Neurotrauma Initiative (Australia) to map the research addressing important questions about treatments, diagnostic tests, prognosis, and cost effectiveness in the broad clinical areas of traumatic brain injury (TBI) and spinal cord injury (SCI). The project involved identifying the scope of clinical issues in pre-hospital, acute, and rehabilitation (long-term care) for TBI and SCI; identifying key questions in the area; and developing evidence maps to support strategic allocation of research funds.

Although a number of sources, including, but not confined to, electronic databases [5, 6], were routinely checked as part of this project, this paper describes an evaluation of just the electronic database-searching procedures and methodologies that were developed to populate the evidence maps. Pragmatic changes to otherwise rigorous and accepted procedures were done only after consideration of time and benefit. At the end of the project, a newly developed evidence mapping search method was compared with highly sensitive systematic review searches using PubMed MEDLINE as the test searching platform. The evaluation of the effectiveness of these two methods was based on the following parameters: yield, sensitivity, time requirements, and resource use.

**METHOD**

In the evidence-based methodology from which evidence mapping methods initially derived, the systematic retrieval of the best available evidence is an early and integral step [7, 8]. A typical search for evidence in an electronic database retrieves references from the intersection of two to three sets of terms relating to the key aspects of the question, commonly those sets that identify the population (by condition, for example), clinical setting, and interventions under review. (In electronic database searching, the Boolean operator “OR” is used to gather like terms into a group, while the Boolean operator “AND” is used to find the intersection or overlap between the groups). Over time, the groupings of terms sets in the “gold standard” of comprehensive searching for evidence have tended to become more inclusive and the search lines longer. This, in turn, has meant that there are increased numbers of references that must be reviewed for validity, clinical relevance, and applicability [9].

The Cochrane Collaboration publishes a useful and detailed handbook for authors and developers for systematic reviews of interventions [10]. It includes a chapter on searching because using appropriate searching techniques is a vital preliminary step in finding evidence for a systematic review. Initially, searches for this project followed these Cochrane procedures, although the restriction to randomized controlled trials was not followed, as this is inappropriate for a review of all evidence, available or not, in a given field. Over time, the searches evolved to better answer the requirements of evidence mapping searches. The change can be best described in relation to a key point of the Cochrane handbook: “Searches should seek high sensitivity which may result in relatively low precision” [10]. For the first two reviews (pre-hospital care and rehabilitation) conducted for this project, highly sensitive and low precision searches were conducted. The number of retrieved references proved unworkable with the available staff resources. For the third phase of care (acute care), both a highly specific and a highly sensitive search strategy were employed, and retrieval rates were compared.

To compare the two approaches, six questions (Table 1, online only) were randomly selected from the existing TBI evidence maps. Those references that had been accepted by reviewers because they matched predetermined eligibility criteria for inclusion in terms of study type, participants, and phase of care [2, 10] were then used to evaluate the success of
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Table 2

Comparison of retrieval of “included references” for six evidence-based and highly sensitive searches

<table>
<thead>
<tr>
<th>Search</th>
<th>“Included” citations retrieved from all databases*</th>
<th>“Included” citations available in MEDLINE†</th>
<th>Total citations retrieved in evaluation searches</th>
<th>Number of included citations found</th>
<th>Number of included citations missed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EM</td>
<td>HS</td>
<td>EM</td>
<td>HS</td>
<td>EM</td>
</tr>
<tr>
<td>1</td>
<td>27</td>
<td>24</td>
<td>306</td>
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<td>23</td>
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<td>9</td>
<td>8</td>
<td>177</td>
<td>310</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>184</td>
<td>155</td>
<td>1,818</td>
<td>2,599</td>
<td>120</td>
</tr>
</tbody>
</table>

EM—evidence-based.
HS—highly sensitive.
† Column 1 lists the total numbers of references for the six traumatic brain injury (TBI) questions included in the original report that were identified from sources including (but not limited to) the databases: CINAHL, Ovid EMBASE, Ovid MEDLINE, PsycINFO, Cochrane Library, Web of Science, PubMed MEDLINE, IndMed, KoreaMed, LILACS, and Panteleimon.
‡ Column 2 lists the total numbers of the report references from column 1 that were available in PubMed MEDLINE only and used as the “included” references for the evaluation described in this paper.

The new search method. These articles are referred to as “included” articles below.

A new evidence mapping (EM) search string was developed for each of the six questions for both the condition (TBI) and the intervention: The same TBI string was combined in each search with different sets of terms that described the intervention. Only the most specific Medical Subject Headings (MeSH) and those text words that appeared frequently in relevant articles identified during the project were used to develop the sets of search terms. For example, the Ovid string used to search TBI in the EM search was:

Brain Injuries/ or Cranioencebral Trauma/ or ((head* or brain*) adj2 (injur* or trauma*))

For the comparison, the more traditional Ovid highly sensitive string (HS) used the strategy:

exp Cranioencebral Trauma/ or exp Brain Edema/ or exp Glasgow Coma Scale/ or exp Glasgow Outcome Scale/ or exp Unconsciousness/ or exp Cerebrovascular Trauma/ or ((head or cran$ or cerebr$ or capitis or brain$ or forebrain$ or skull$ or hemisphere$ or intra-cran$ or inter-cran$) adj3 (injur$ or trauma$ or lesion$ or damag$ or wound$ or destruction$ or oedema$ or edema$ or fracture$ or contusion$ or concuss$ or commotion$ or pressur$)),ti,ab.

The HS and shorter EM strategies were compared in terms of:
1. total citation yield,
2. number of included studies retrieved,
3. number of included studies missed, and
4. staff time used.

RESULTS

For the 6 questions combined, 85% of all included report references were indexed in PubMed MEDLINE.

The HS strategy retrieved 43% more total citations than the EM strategy (2,599 vs. 1,818). The HS search retrieved also slightly more of the included references compared with the EM strategy (125 (81%) vs. 120 (77%)) (Table 2). The number of included citations compared to irrelevant citations that the EM strategy retrieved was substantially higher than for the HS strategy (1:14 compared to 1:19). Neither approach found all the records that had been included in the original evidence map, because some of those included references had been located solely in the other databases or sources routinely searched by the GEM team (see “Method” section above).

Of the five included articles that the EM search missed and the HS search found, three were not written in English and were only marginally related to the clinical topic. They were only included in the maps as articles of possible interest. Of the two
remaining articles, one was a case series and the other was an interrupted time series with no control group. Both of these articles were indexed incorrectly for TBI in MEDLINE, and there was no mention of the injury group in either the title or the abstract. These articles had marginal relevance and were not found in the reference lists of other articles.

Therefore for this study, use of the EM strategy did not miss any reviews or trials that were of significance to the research questions being investigated. Table 2 details the comparison of six shorter (EM) to longer (HS) search strings for inclusions in all databases, inclusion in MEDLINE, total numbers retrieved by each string, total “included” articles found by each, and total “included” articles missed by each.

Based on records of staff time spent using conventional review methods for article selection, the 781 fewer articles retrieved by using the EM string would have resulted in a saving 19.5 hours of staff time over the 6 questions.

DISCUSSION AND CONCLUSIONS

The gold standard HS search methods developed for systematic reviews are not always cost effective for evidence mapping, in terms of resource use. Like an increasing number of information professionals [11], the GEM project team needed to develop a manageable way of finding research evidence for mapping because the project would have been unworkable using conventional HS searching procedures. The EM search method described here was developed over the life of the GEM project. It is marginally less sensitive but results in fewer citations needing to be reviewed.

The EM search strings described here were simpler than those used in a conventional search and yet effectively identified relevant references using less staff time. For example, a total of fifty-five questions were identified for mapping at GEM. Using in-house time records as a guide, if an HS search strategy had been used to answer the six questions evaluated here, the project timeline would have been extended by approximately six weeks. This equates to an additional year if that calculation is extrapolated to all fifty-five of the questions that GEM answered.

At the end of the first stage of the project (three years), it appears that the EM string makes for more workable evidence mapping. Although it has only been tested for use with one clinical condition, results indicate that the EM search method is unlikely to miss the key articles necessary for decision making. The five missed articles in the evaluation set of “included” references were only of peripheral interest (at best) to the research questions. In the context of the evidence map, the small risk of missing vital references is outweighed by the benefit of being able to produce more evidence maps within time and budget restraints. The results of this study suggest that the use of HS searches is not worth the effort for evidence mapping.

Given that articles are sometimes misclassified (as were two of the five articles missed using the EM strategy), this study also highlights the importance of searching various databases in addition to other methods, such as snowballing reference lists of systematic reviews [5, 6], when preparing evidence maps.

Managing the retrieval and review of evidence is a fundamental part of remaining current in medical research. Although the authors only considered two health conditions, we hope that our findings will encourage other searchers to try our method, as we believe that the simplified process can be applied across other clinical settings.

Information workers providing a web repository for information on SCI and TBI must keep resource use as effective as possible to continue to respond to the inevitable change and growth in procedures and ways of explaining information [11, 12]. GEM work processes and maps are currently published and regularly updated on the project website <www.evidencemap.org>.

REFERENCES

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