Commentary on EPC methods: an exploration of the use of text-mining software in systematic reviews

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This commentary summarizes our recent peer-reviewed Agency for Healthcare Research and Quality (AHRQ) white paper EPC Methods: An Exploration of the Use of Text-Mining Software in Systematic Reviews followed by a discussion of current and future issues [1].

Our methods workgroup (comprised of three professional librarians, an Evidence-based Practice Center (EPC) project manager, an EPC senior analyst, and two AHRQ task order officers) explored the availability and utility of text-mining tools to support systematic reviews (SRs). The full white paper includes a qualitative analysis of eight key informants (KIs) interviews, a summary of findings from 122 relevant articles, and a descriptive listing of 111 tools. Two recently published SRs covering screening and data abstraction were identified [2,3]; thus, our white paper focuses primarily on the searching process and secondarily on other SR processes.

Systematic reviews have been defined as "attempts to collate all empirical evidence that fits prespecified eligibility criteria to answer a specific research question…." [4] Although SRs are a cornerstone of evidence-based practice, the cost and time required to conduct SRs are of concern within the field [4,5]. AHRQ, through its EPC program, has conducted methodological research to improve efficiency, including development of the Abstrackr

screening tool with the Brown University EPC and also on methods for updating reviews [6–8]. Other organizations, such as the EPPI-Centre, have long been interested in this technology as evidenced by their publications, software, and training [2,3,9–11].

Text mining covers various techniques and tools used to detect patterns and extract knowledge from unstructured natural language text. Text mining uses statistical approaches to explore (eg, co-occurrence, frequencies of words) and categorize (eg, clustering, classification) text-based information to support knowledge discovery while minimizing human effort. For details on specific types of text-mining algorithms, readers are encouraged to see Thomas et al.'s descriptions of automatic term recognition, document clustering, automatic document classification, and document summarization techniques [11]. We defined a text-mining tool to be any software or application used in the context of the SR process; some listed tools are re-purposed from their intended application (eg, EndNote and Excel) and were included based on KI's usage of them (text mining is an imbedded function within a number of software packages).

Table 1 describes tool functionality by SR process step and advantages/disadvantages and Fig. 1 illustrates estimated levels of technical expertise required to run text-mining tools. To find an up-to-date list of tools by review step, the SR toolbox web site (http://systematicreviewtools.com) is recommended.

1. Current issues

1.1. Are text-mining tools suitable to systematic review methods?

Before evaluating a tool, users should consider specific needs and define expected value of text-mining tools/

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Table 1. Functionality, advantages, and disadvantages of text-mining tools

SR process step	Advantages/disadvantages
Searching for literature	Identification of keywords, and so forth

Identification of
- keywords
- synonyms
- subject terms
	Advantage
	  Supports easy review of a far larger corpus of preliminary results for identification of keyword/
	  subject search terms than would be feasible otherwise (potential to improve time efficiency,
	  use of reproducible/objective method, and improved search strategies)
	Disadvantage
	  Most TM tools geared to search Medline/PubMed so will likely not be useful for topics in other
	  disciplines

Filter creation	Filter creation
	Advantage
	  Creation of reusable tool to identify citations in a database (use of reproducible/objective
	  method and improved search strategies)
	Disadvantage
	  1) Filter development takes time that may/may not be warranted given search topic
	  2) Filters tend to be very sensitive and may return too many results to be useful to review team

Screening citations
Prioritization of most relevant citations first
Fulfilling second screener role
	Prioritization
	Advantage
	  Relevant citations are displayed first for screening review, so review team can begin work on
	  these while completing review of all citations (potential to improve process)
	Second screener
	Advantage
	  TM tool determines relevant citations and compares against human screener's selections (po-
	  tential for time efficiency)
	Disadvantage
	  Potential for missing relevant citations

Abstracting data
Extraction of data:
  *P*atient
  *I*ntervention
  *C*ondition
  *O*utcome
	Advantage
	  Validation of human-extracted data (potential for time efficiency and increased accuracy)
	Disadvantage
	  Not currently ready to be used without human oversight; additional TM tool development and
	  evaluation required

Appraising quality	Advantage
	  Validation of human appraisal (potential for time efficiency and increased accuracy)
	Disadvantage
	  Not currently ready to be used without human oversight; additional TM tool development and
	  evaluation required

Updating reviews
Identification of new studies
	Advantage
	  Potential for time efficiency
	Disadvantage
	  Not currently ready to be used without human oversight; additional TM tool development and
	  evaluation required

Abbreviations: TM, text mining; SR, systematic review.

technologies. Selection criteria will vary by intended application within SR processes. For example, automated text/document categorization, retrieval, and classification features may help reduce or redistribute workload; clustering and co-occurrence analyses may inform, improve search strategy development; and frequency analysis may aid in the prioritization of interventions or outcomes of interest and refinement for topics with large literature bases.

Future evaluations of features and usefulness of text-mining tools should include simulation and replication studies using SRs and/or case studies to assess performance [12]. With numerous tool sources and a variety of ways to leverage text-mining technology, it is critical to cull a subset of those most likely to improve SR quality/efficiency. One KI summed it up, "[there are] two optimality metrics: one is how fast you do it and the other is how accurately you do it, and these are competing…you would have to say how much you trade the one versus the other in order to rank order algorithms…. we need a lot of empirical work in terms of eliciting metrics from experts in order to answer the question of evaluation" [13].

1.2. Cost

Despite most tools being freely available, additional costs include specialized IT (installation, support, server space) and staff training. Although most authors and KIs think text mining can reduce SR workloads, many see them as augmenting rather than replacing existing tools or team members—thus, no savings in these other areas are projected.

1.3. Efficiency

Comprehensive, high-quality SRs may take a year or more to complete, with literature screening representing