A Hybrid Approach to Semi-automate the Evaluation of the Certainty of Evidence for Living Systematic Reviews and Meta-analysis

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Abstract

We use living interactive evidence synthesis (LIvE) framework to create and maintain living, interactive systematic reviews (LISRs). With each new update, it is critical to report any changes to confidence level or certainty of synthesized evidence (CoE) for patient important endpoints. Ascertaining CoE is a complex task and thus challenging in the setting of LISRs. Therefore, we propose a hybrid approach, which leverages an interactive web-based graphical user interface and rule-based algorithms to accelerate the CoE evaluation.

Introduction and Background

Certainty of evidence (CoE) is widely used in systematic reviews and meta-analysis (SRMA) to reflect the level of confidence in the results across different patient-important endpoints[1]. The assessment of CoE for a given outcome generally requires a detailed assessment of results generated from pairwise meta-analysis (PWMA) in the context of risk of bias, inconsistency, indirectness, imprecision, and publication bias. In network meta-analysis (NMA), indirect evidence is additionally assessed for intransitivity, and network estimates are evaluated for statistical inconsistency (incoherence)[1,2]. This evaluation requires a significant amount of domain expertise and manual efforts, which takes considerable time and resources.

While there are several tools to facilitate other steps involved in a SRMA, dedicated efforts to facilitate adjudication of CoE are scarce. For example, RobotReviewer[3,] automates the assessment of only one domain (risk of bias) and even that is limited by lack of validation and suboptimal accuracy. The lack of efficient means to assess CoE presents a challenge for keeping systematic review living as it requires repetitive evaluations whenever new studies or updated reports of previously included studies are incorporated into the existing body of evidence. While CoE cannot be fully automated and implemented mechanically considering that it requires a necessary amount of subjectivity in the process, some if not all factors can be automated. Therefore, we propose a hybrid approach that integrates an interactive web-based graphical user interface (GUI), ML/NLP based techniques to accelerate the CoE evaluation.

Methods

The proposed approach consists of three components to provide a user-centered solution, including automated processing, semi-automated extraction, semi-automated analysis, and interactive evaluation (Figure 1A).

The automated processing component (Figure 1A [1]) provides the metadata and full text of included studies to the user interface for CoE evaluation. The final list of eligible studies is imported into our system for data pre-processing. Subsequently, the corresponding PDF files with associated metadata (e.g., study identification information - title, authors, publication year, journal of publication, etc.) are automatically extracted and saved into our project database for later access. In addition, the unstructured or textualized data (e.g., abstract and full text) will be sent to the next module for further detection.

The semi-automated extraction (Figure 1A [2]) provides a web-based user interface to pre-define the essential parameters required to execute a meta-analysis which includes the type of outcome, the measure of effect, choice of model, method of estimation, and statistical framework. The users also extract data regarding certain domains of CoE that needs critical human input, including the risk of bias and indirectness. The extraction data is subsequently provided to the semi-automated analysis component, to the rule-based evaluation of CoE domains (inconsistency, imprecision, publication bias), and to the interactive evaluation component for the final assessment of CoE.

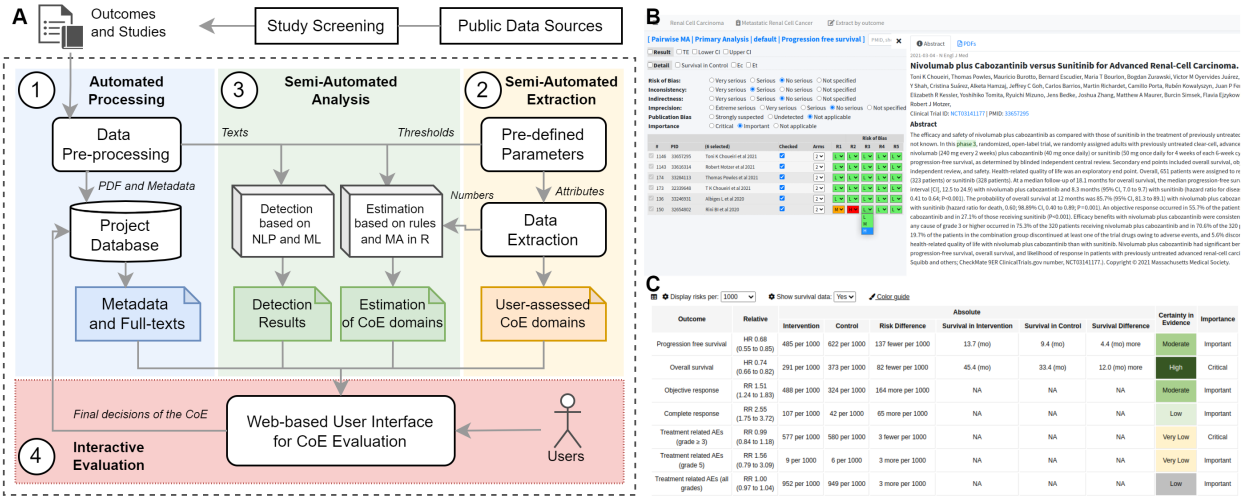

Figure 1. (A) The framework of proposed approach, including [1] automated processing, [2] semi-automated extraction, [3] semi-automated analysis, and [4] interactive evaluation; (B) Interactive web-based user interface. Users could modify and make the final decision on the assessment of CoE; (C) Presentation of living meta-analysis results in an interactive Summary of Findings table.

The semi-automated analysis component (Figure 1A [3]) facilitates the assessment of CoE domains (inconsistency, indirectness, publication bias) by integrating data from other components automated processing, and interactive evaluation. We implemented a rule-based algorithm based on the Grading of recommendation, assessment, development, and evaluation (GRADE) approach[1] to assess inconsistency, imprecision, and publication bias. The results generated automatically are provided to the interactive evaluation component for final assessment by a human-in-loop.

The interactive evaluation component (Figure 1A [4]) facilitates the final assessment of CoE by a human-in-loop. It provides users with a web-based GUI (Figure 1B), which includes the end results of the semi-automated analysis and semi-automated extraction components. The user interface can display the metadata of each study, as well as the full-text PDF file in one workspace to help users focus on the final evaluation tasks. The assessment of CoE for each patient-important endpoint, as finalized by the user, is subsequently processed to the project database and presented as an interactive summary of the findings table on the living website.

Results and Discussion

The final assessment of CoE for patient-important endpoints is presented in a table that summarizes the results of living meta-analysis (Summary of Findings table, Figure 1C). This hybrid approach, using human assessment coupled with rule-based algorithms and ML/NLP techniques, facilitates the complex tasks involved in the assessment of CoE.

We have applied this novel approach to our existing living evidence projects on metastatic kidney cancer and cancer-associated thrombosis for the assessment of CoE. Qualitative feedback from experienced researchers suggests that our approach can decrease the workload. The next steps include formal user testing, ongoing enhancements to the user interface, refining rules, increasing utilization of ML/NLP approaches, and supporting CoE assessment for network meta-analysis.

References

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