

Development of an interactive web-based report to conduct and visualize evidence synthesis for facilitating evidence-based

decision making in health care

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Objectives

- > Evidence synthesis is a recognized methodology for aggregating direct and indirect evidence to provide information on the comparative efficacy or safety that is commonly used for Health Technology Assessment (HTA). The appropriate method for evidence synthesis is recommended to be based on a structured process.¹
- > According to a recent comparison of national guidelines for evidence synthesis, these aggregate guidelines do not include requirements that are mutually prohibitive and it is possible to perform a single analysis for submission to an expanded list of national jurisdictions.²
- > As multiple methods for evidence synthesis exist, and sometimes these are not mutually exclusive, evidence synthesis may require complex and cumbersome technical reports to ensure the required time points, evidence networks, data cuts and endpoints are described in enough detail for all end users.
- > There have been advances within HTA to suggest that documents should be living documents rather than static one-off reports, to facilitate this, a more automated and flexible way to report evidence synthesis is required. For meta-analysis this can be conducted however some forms of evidence synthesis may require more consideration.³
- > Additionally, journals have permitted the submission of infographics presented in video format (MP4/GIF) to depict the change in outcomes over time, while these may not be suitable for all audiences it provides a useful way to understand complex data in a short time.⁴
- > Based on the increased use of evidence synthesis and their complexity, this research aimed at understanding existing approaches to reporting evidence synthesis using graphical user interfaces (GUIs) and to develop a web-based tool that allows users to update and report evidence synthesis in a uniform manner.
- > The objective being that this tool would provide an innovative framework that takes advantage of a GUI developed through the R package Shiny to allow for superior data interaction and high-quality visualizations, allowing for greater efficiencies in the future and support potential "living" HTA documents.

Methods

- > A process to optimize evidence synthesis reporting (shown in Figure 1) was first conceptualized.
- > A review of existing R packages and interactive dashboards was conducted through a desktop search but also through a targeted search through PubMed, to understand existing functionalities and guidelines. The search was conducted by one researcher, with any uncertainties checked with a second researcher.
- > Any relevant data was captured in a data extraction form.
- > The search strategy used did not include any terms for population, intervention, comparator with only terms applied to the study type and outcome, as the aim was to identify relevant R packages or research.
- > A web application was developed in R using the Shiny package and allowed the user to update analysis, test user defined sensitivity analysis, visualize outputs and export findings to an automated report to facilitate a comparison to existing reporting guidelines.
- > For the purpose of this project, a meta-analysis was developed to demonstrate the capabilities and functionality of R-Shiny in effectively conducting this analysis.
- > Existing R-packages were used to conduct the meta-analysis, this approach was aligned with the reproducibility aspect of this study.
- > The ability for this approach to be applied for other methods of evidence synthesis are considered.
- > The flexible programming approach undertaken allows for the ability to incorporate additional sensitivity analyses and outcome measures in later versions of the application.
- > The usability of the tool and required functionality was tested on a number of independent experts to gain consensus on ways in which this tools would be able to support future analyses.
- > All R code was independently reviewed through a quality control checklist, and results generated using sample data validated against the corresponding published analysis.

Figure 1. Evidence synthesis optimization process flow.



References:

1. Cope S, Zhang J, Saletan S, et al. A process for assessing the feasibility of a network meta-analysis: a case study of everolimus in combination with hormonal therapy versus chemotherapy for advanced breast cancer. *BMC Med.* 2014;12:93; 2. Laws A, Tao R, Wang S, Padhiar A, Goring S. A Comparison of National Guidelines for Network Meta-Analysis. *Value in Health.* 2019;22(10):1178-1186; 3. Thokala P, Srivastava T, Smith R, et al. Living Health Technology Assessment: Issues, Challenges and Opportunities. *Pharmacoeconomics.* 2023;41(3):227-237; 4. Leonardi CL, See K, Burge R, et al. Number Needed to Treat Network Meta-Analysis to Compare Biologic Drugs for Moderate-to-Severe Psoriasis. *Adv Ther.* 2022;39(5):2256-2269.

Figure 2. Overview of the meta-analysis web-app structure.

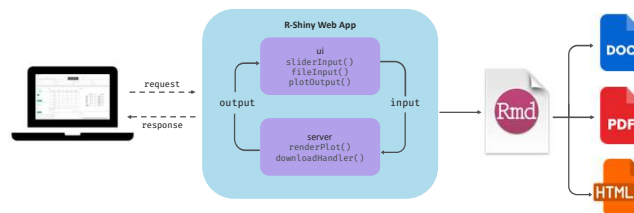
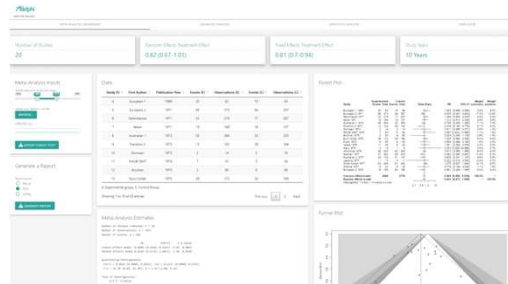


Figure 3. Visualization of the interactive user interface.



Results

Literature review results

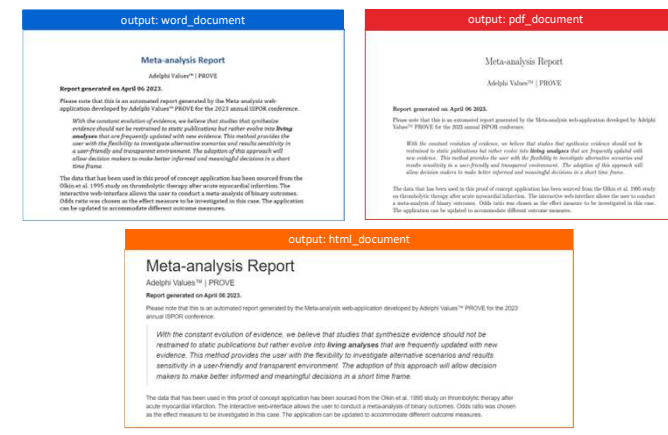
- > The targeted search identified one web-based tool from PubMed[®] with the associated R package also identified.
- > The R package identified was developed by the NIHR Complex Review Support Unit (Metalsint).
- > This tool simplified the running of network meta-analysis, and allowed users to further interrogate the analysis beyond what would be available through a static technical report.
- > The tool included the ability to:
 - Read-in, edit data, and plot the user-specified network of evidence.
 - Conduct analysis and present pairwise comparisons.
 - Summarise results in a forest plot.
 - Conduct inconsistency analysis.
- > The review findings reveal an important gap in evidence around updates to evidence synthesis reporting frameworks which have not been challenged to match the increasing need for evidence-informed decision making.
- > As the identified tool did not include a reporting function or provide any analysis to assess biases, it was determined that an updated and all-encompassing tool would be able to support the evidence synthesis process.
- > Therefore, it was considered that a digital tool that could automate result reporting could be used to assist researchers, health policy decision makers, and other stakeholders to transparently synthesize evidence and make better informed decisions.

Results

Interactive web-based report

- > First a meta-analysis was developed in R before a R-Shiny user interface was developed to provide a user friendly web app. The web app was developed to read in data from .csv files
- > To support the reporting of the analysis an R-Markdown file was developed to allow the user to export a report to Word, PDF or HTML. The generated reports are based on the user selected settings (Figure 4).
- > Figure 2 shows an overview of the structure of the web app.
- > Within the user interface (shown in Figure 3) we included examples of user inputs, in the user interface we considered these to be year of publication, however this could be expanded to any required inclusion and exclusion for scenario analysis.
- > The web app was developed to have a user friendly dashboard but also to have subsequent advanced settings, a user guide and sensitivity analysis.

Figure 4. Visualizations of the generated reports in different formats.



Conclusions

- > The web-based tool was found to provide a clear and concise summary of results that support clear communication of the analysis compared to standalone technical reports. By not requiring prior coding knowledge to run the analysis, the analysis can be tailored to different audiences.
- > Further research into conducting a range of analysis and informing the decision making process to identify the most relevant type of analysis will enhance the usability of the tool.
- > Additionally for this web app to support a living HTA, seamless integration with systematic literature reviews, data extraction and the subsequent economic models requiring the evidence synthesis output will be required.
- > With the constant evolution of evidence, we believe that studies that synthesize evidence should not be restricted to static publications but rather evolve into living analyses that are frequently updated with new evidence, and allow users to investigate alternative scenarios and result sensitivity in a user-friendly and transparent environment. The adoption of this approach will allow decision makers to make better informed and meaningful decisions in a short timeframe.