

**Improving Access to and Usability of Systematic
Review Data for Health Systems Guidelines
Development**



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Key Messages

Purpose of Project

Identify and test interactive methods to make the large amount of data in an Evidence-based Practice Center (EPC) systematic review more accessible for decision makers at Oregon Health & Science University.

Key Messages

- We identified two functionalities existing software could address:
 - Ability to drill down from summaries to increasing levels of detail.
 - Ability to slice and dice the data into subgroups corresponding to specific interests.
- To use such tools, the EPCs will need staff with informatics skills, and the Agency for Healthcare Research and Quality will need to verify Web strategies for public access.
- Alternate formats may improve utility of EPC report data to guideline committees in learning health systems.
- The recommended pilot extension could confirm usefulness of prototypes and resources needed.

This report is based on research conducted by the Pacific Northwest Evidence-based Practice Center (EPC) under contract to the Agency for Healthcare Research and Quality (AHRQ), Rockville, MD (Contract No. 290-2015-00009-I). The findings and conclusions in this document are those of the authors, who are responsible for its contents; the findings and conclusions do not necessarily represent the views of AHRQ. Therefore, no statement in this report should be construed as an official position of AHRQ or of the U.S. Department of Health and Human Services.

None of the investigators have any affiliations or financial involvement that conflicts with the material presented in this report.

The information in this report is intended to help healthcare decision makers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of healthcare services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information, i.e., in the context of available resources and circumstances presented by individual patients.

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Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-based Practice Centers (EPCs), sponsors the development of evidence reports and technology assessments to assist public- and private-sector organizations in their efforts to improve the quality of healthcare in the United States. The reports and assessments provide organizations with comprehensive, science-based information on common, costly medical conditions and new healthcare technologies and strategies. The EPCs systematically review the relevant scientific literature on topics assigned to them by AHRQ and conduct additional analyses when appropriate prior to developing their reports and assessments.

To improve the scientific rigor of these evidence reports, AHRQ supports empiric research by the EPCs to help understand or improve complex methodologic issues in systematic reviews. These methods research projects are intended to contribute to the research base in and be used to improve the science of systematic reviews. They are not intended to be guidance to the EPC program, although may be considered by EPCs along with other scientific research when determining EPC program methods guidance.

AHRQ expects that the EPC evidence reports and technology assessments will inform individual health plans, providers, and purchasers as well as the healthcare system as a whole by providing important information to help improve healthcare quality. The reports undergo peer review prior to their release as a final report.

If you have comments on this Methods Research Project they may be sent by mail to the Task Order Officer named below at: Agency for Healthcare Research and Quality, 5600 Fishers Lane, Rockville, MD 20857, or by email to epc@ahrq.hhs.gov.

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Improving Access to and Usability of Systematic Review Data for Health Systems Guidelines Development

Structured Abstract

Objectives. Evidence presented in systematic reviews informs the development of healthcare practice, guidelines, and policy. The inherent complexity and quantity of data in systemic reviews may impede understanding and use in decision processes, but little evidence exists on transforming large volumes of these data into accessible formats for end users. The objectives of this Evidence-based Practice Center (EPC) pilot project were (1) to identify the information needs of health systems guideline/protocol developers; (2) to assess existing, off-the-shelf software or Web platforms that would allow creation of interactive presentations of systematic review data in formats that would address the identified needs, and (3) to test the ability of selected software/platforms to make the large amount of data included in a recent systematic review of chronic pain management more accessible for decision makers at Oregon Health & Science University.

Methods. To develop and test alternative formats for dissemination, we assessed stakeholder needs through qualitative interviews with a department director and four health system content experts. We reviewed interview notes and identified the key themes in team discussion, and arrived at consensus. We then conducted a literature search regarding core functionalities desired in evidence summaries and systematic reviews, as described by the content experts. Next, we compared recommendations from the content experts and the literature search to several existing software tools in order to select two tools for the pilot test. We imported data from a recent systematic review on chronic pain into the selected tools to mock up example outputs. Finally, we solicited reactions from the department director and six health system content experts (four of whom were interviewed initially) on the mocked-up report examples in terms of accessibility and utility, and we based recommendations for next steps on these assessments and our experience.

Results. The key theme that emerged from the initial interviews with content experts was the need for two core functionalities: the ability to drill down from a general overview to specific more information and the ability to select subsets of evidence from a larger review. We identified two tools that provided these functions and that met our other criteria: MAGICapp is a platform for evidence summaries; Tableau is a data management and visualization tool. MAGICapp required less time and skill to mock up, as the data were entered manually into the Web-based platform, while Tableau required more time and a staff member with knowledge of informatics such as the ability to set up the relational databases for the dashboard. MAGICapp parameters required the data output to follow the structure of the pain review and allowed users to drill down to granular detail; Tableau allowed users to explore evidence without adhering to the organization of the review, but could not provide the granularity found in MAGICapp. Neither of the two tools we tested were able to fulfill both core functionalities, drilling down to specific study data and reviewing subsets of evidence outside the confines of the organization of the pain review. The second round of health system content expert interviews provided positive feedback on the products, aesthetically as well as for their potential functionality. Respondents perceived Tableau as ideal for content experts reviewing data, as the functionality allows users to query the

data in multiple ways. Respondents perceived MAGICapp as the better choice for multidisciplinary groups or decision makers less familiar with the data, given the tool's organized structure and capacity for explanatory text.

The two key themes from the second-round interviews and our evaluation were (1) the need for the learning health system administrators to consider the level of expertise of the end users, as those with more or less familiarity with a set of data may require the granularity of MAGICapp or the freedom of Tableau and (2) the need for EPCs to test one or both prototype in an actual review from the beginning in order to accurately estimate what additional staff time and expertise is needed to prepare, import, and manage data beyond the traditional EPC report formats.

Conclusions. The results of this “proof-of-concept” prototype development demonstrate that existing tools could be used to make large systematic reviews more accessible and usable. However, an individual tool may not have the capacity to provide all desired functionalities, and each tool has differing requirements for time, data management, and staff expertise. To better understand the actual time required, the data storage needs, implications for EPCs and learning health systems, and issues related to Section 508 accessibility standards and government data rights, we recommend a follow-on pilot be conducted to allow systematic review teams to test these tools as integrated components of one or a small number of future reviews. This follow-on research would provide realistic data on the resources needed to generate systematic reviews in alternative formats and allow further assessment of whether these formats can increase uptake of EPC reports within learning health systems.

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Introduction

Background

The translation of research into clinical practice, guidelines, and policies is critical to efforts of learning health systems to improve the quality of patient care. Groups and individuals in learning health systems make decisions based on many factors, including but not limited to research evidence. When research evidence is uncertain, perceived as complex, or difficult to use it is less likely to be incorporated to support local policy and practice needs.

Systematic reviews provide a large volume of data that can be used by decision makers in these health systems; however, the complexity of the data and current standards for reporting and formatting reviews often results in long text documents with numerous tables and figures and extensive appendices. These dense, static data presentations may be difficult to distill into relevant, useful information for specific users, which can hinder uptake and implementation of evidence-based healthcare.¹⁻⁹ By creating tools that allow users to interact with the data, with the potential to provide the level of detail desired or allow formulation of unanticipated questions, systematic review information may be made more accessible to users working to improve quality of care. However, literature evaluating the use of novel data visualization approaches and formats to facilitate uptake of reviews by stakeholders is sparse.¹⁰⁻¹⁴ AHRQ,⁶ the Cochrane Collaboration,^{5, 15} and others have called for experimentation and research on optimizing communication and dissemination tools as one approach to improving evidence-based decision making among learning health system stakeholders.

AHRQ's Evidence-based Practice Centers (EPCs) conduct systematic reviews for use by groups including professional organizations, healthcare organizations, and federal agencies to inform clinical practice, guidelines, policy, and research priorities. The substantial quantity of data in these reports may hinder how and when the evidence is used; to date, few research studies, evaluations, or reviews exist on tools to capture and present the wealth of evidence in an accessible way for a range of end users. AHRQ engaged EPCs in developing and testing dissemination approaches and products using data from existing EPC reports. By repackaging EPC review findings in a new format, our ultimate goal is to enhance uptake of review findings to inform guideline and policy work in learning healthcare systems.

Rationale

In 2016, AHRQ engaged the Pacific Northwest EPC to develop a comparative effectiveness review on Noninvasive Nonpharmacological Treatments for Chronic Pain.¹⁶ The report focused on five of the most common types of chronic musculoskeletal pain: low back pain, neck pain, osteoarthritis, fibromyalgia, and tension headache. The timing of the chronic pain report coincided with ongoing work at Oregon Health & Science University (OHSU) to develop guidelines on opioid prescribing; disseminating the evidence on noninvasive nonpharmacological treatments from our report to OHSU stakeholders would facilitate related guideline development. Consequently, we selected the chronic pain report as our model to develop and test presentation and dissemination tools.

Objective

Our objective was to identify and test interactive methods to make the large amount of data included in the chronic pain report more accessible for decision makers at OHSU, without

distorting the information, losing clinically meaningful information, or requiring excessively large amounts of staff time. As OHSU is an academic center, clinicians have educational and leadership responsibilities beyond the typical provider role, so they are a relevant type of health system leaders. Providers participate both in identifying the system's needs for guidelines and protocols and in developing and implementing evidence-based practice tools. Specifically, we envisioned developing an application to present complex information from our chronic pain report in a readily usable format, with the ability to drill down to specific topics as well as identify slices of data that correspond to more narrow areas of interest. While the findings may be of interest to other users of AHRQ systematic reviews, our focus in this pilot project was to create a dissemination product to inform ongoing work by OHSU clinicians who are developing pain management guidelines.

Methods

Health System and Representative

We engaged the Oregon Health & Science University (OHSU) health system in Portland, Oregon. Our primary health system partner was Elizabeth Crabtree, Ph.D., M.P.H., the OHSU Director of Clinical Integration and Evidence-based Practice, OHSU Healthcare. Dr. Crabtree provided health system leadership in the areas of strategic planning, strategy execution, and implementation of clinical integration of evidence-based policy and practice. She provided an email confirming her willingness to participate in this methods project (Appendix A), and she served as a member of the core Evidence-based Practice Center (EPC) team to plan the dissemination product and facilitate testing and evaluation

Other members of the project team were Annette Totten, Ph.D., an EPC investigator who has incorporated alternate formats and innovative graphics in multiple reports for AHRQ projects she has led; Connor Smith, B.S., Informatics Research Associate; Kenneth Dunham, B.A., Clinical Informatics Graduate Student, Rebecca Jungbauer, Dr.P.H., EPC Research Associate, and Elaine Graham, M.L.S., EPC Program Manager.

Process

To develop and test our dissemination product, we assessed stakeholder needs and reviewed literature regarding dissemination of systematic reviews; identified the core functionalities desired in a dissemination product; evaluated existing software on its ability to provide that functionality; mocked up select data from the EPC chronic pain report using off-the-shelf software; and obtained feedback from our health system partner and guideline panel members, as well as other EPC investigators and staff.

Needs Assessment

To assess the unmet needs of stakeholders using evidence for guideline development, we conducted short (15- to 30-minute) qualitative interviews with four content experts at OHSU (see Appendix B for the questionnaire, interview summaries, and respondent roles at OHSU). These experts had previously participated on panels responsible for developing guidelines for our health system regarding colorectal cancer screening, cystic fibrosis, and supplemental feeding in neonates. We elicited feedback on sources and presentation of evidence used in guideline development, including EPC reports, as well as suggestions to facilitate ease of use and uptake of information in the future. To analyze the qualitative interviews, we met as a team to discuss emergent themes across all four interviews, and arrived at a consensus as to the key takeaways.

Next, to identify any evidence to date on dissemination of clinical information, we conducted a literature search using PubMed for peer-reviewed articles published between 2002 and 2017. Articles were selected if they addressed types and formats of evidence synthesis products used by health systems decision makers and tools for considering or promoting use of systematic review evidence in decision making. The 31 retrieved articles^{1, 2, 4, 5, 7-9, 11-13, 17-37} predominantly focused on implementation of disseminated data, rather than interaction with and presentation and use of clinical data in systematic reviews. We repeated the search in July 2018 using combination of index terms from the retrieved articles and reviews to identify new or updated research in MEDLINE[®], Google Scholar, and Scopus[®].^{10, 38-43}

Selected Data

We used data included in Key Question 1 of the chronic pain report¹⁶ for the mockup report examples. Key Question 1 reflected the barriers to review data uptake mentioned in the introduction, including a large volume of complex data, dense static tables, and a rigid structure as defined by the systematic review approach. For example, in Key Question 1 alone, data were extracted from 68 studies reported in 74 articles on 8 interventions and 2 primary outcomes split into 3 timepoints. This was reported in 79 pages, and there were 12 tables and 21 figures.

Evaluation of Examples

Interviews and presentations were conducted with six key stakeholders using the mocked-up example outputs with the chronic pain report data to elicit feedback and provide direction for future changes. We included four content experts from the initial round of stakeholder interviews, as well as two stakeholders working in the university's clinical integration office (see Appendix B). As with the initial interviews, we met as a team to discuss feedback and came to a consensus on the key themes arising in the evaluations.

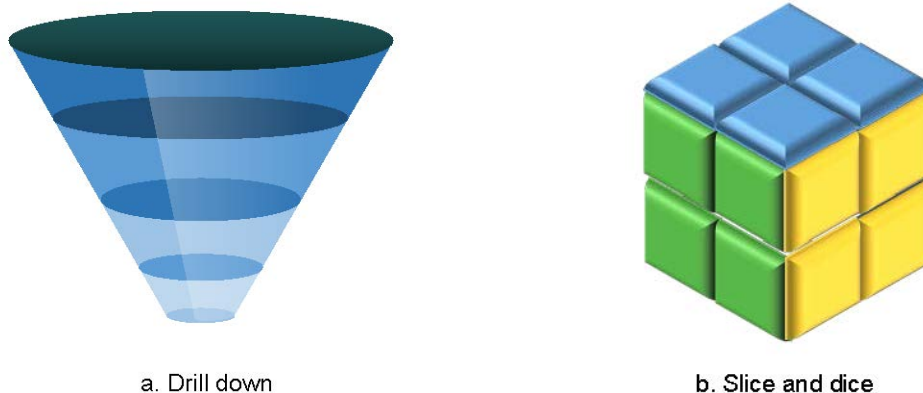
Results

Identification of Core Functionalities

In the initial stakeholder interviews, the four health system content experts noted they had used evidence summaries alongside other sources of information for guideline development, but the data were presented in static tables and figures in handouts and on PowerPoint® slides. Experts also cited the volume of data in tables as a barrier, as well as the perception that the data were not always tailored to the population or setting that was the target for the guidelines.

The key theme that emerged from these interviews was the need for data formatted in a way that allowed “drill down” and “slice and dice” approaches, which could potentially address the need for more accessible and interactive data. In the “drill down” approach, users could move vertically through layers of information from general, overall assessments of the evidence on a topic to more detailed information as needed (Figure 1a). In the “slice and dice” approach, users could move vertically and horizontally through data, grouping information by variables of interest (e.g., populations, interventions, or outcomes) in ways that might differ from those presented in the report (Figure 1b).

Figure 1. Visualization of core functionalities



Software Selection

Based on feedback from health system content experts and findings from the literature review on current trends in information analytics, we identified inclusion and exclusion criteria for selection and evaluation of software tools: intuitiveness, level of complexity, sustainability, and ability to be disseminated. Tools would need to be relatively intuitive and not require a significant amount of training in order to be used. This inherently excluded any tool that was not “off the shelf” and would require significant development time and expertise, particularly computer programming. Tools would also need to be sustainable for the foreseeable future, both at the software development level and at the individual application maintenance level. Lastly, tools would need to result in a product that could be easily disseminated and made freely and publicly available to a general audience similar to how all AHRQ reports are disseminated (i.e., either free or with fee-based licensing by the application developer for public access) We did not include Section 508 accessibility as a selection criterion, as Web accessibility is not inherent in the software tools themselves, but is achieved by design and implementation of an application on a specific website (<https://www.w3.org/WAI/standards-guidelines/wcag/>).

For this “proof-of-concept” prototype development we did not investigate rights in data (intellectual property) issues related to the various software platforms or the implications for release, use, and copyright of data collected and analyses performed under AHRQ contracts with EPCs. (None of the vendors we considered makes obvious claims that customer data belongs to them, as is the case for some vendors of cloud storage, for example.) We cannot speak to other broad issues, such as whether software and/or developed applications related to EPC reviews would be better mounted on a government server (or if linking to an external server would be appropriate) or related issues of reliability, availability, and serviceability.

Several companies currently offer information management and visualization software; commercially available products both reduce the time needed to develop and test a dissemination product and expand the potential for use across multiple systems. In addition to the criteria described above, we limited our selection to software with strong technical support; flexibility in data manipulation and visual presentation; and prior use in academic and research applications to ensure adequate relevance and privacy protections (Table 1).

We selected MAGICapp and Tableau® to move forward into development and testing, as they best met our criteria. MAGICapp is a collaborative, Web-based content management system focused on authoring and publication via electronic platforms. Tableau is a cloud-based analytics platform that interfaces with Microsoft Excel®, allowing for visualization of large data sets. In addition, Tableau assures developers they can use Tableau to build data views that conform to the Web Content Accessibility guidelines (WCAG 2.0 AA). This includes building views that are accessible to users who use screen readers, braille keyboards, keyboard-only navigation, and so on (https://onlinehelp.tableau.com/current/pro/desktop/en-us/accessibility_overview.html).

In terms of relevance to learning health systems, MAGICapp has partnered with the British Medical Journal and the governments of several countries to disseminate evidence summaries, recommendations, and guidelines. Tableau is used by many health systems to monitor and improve patient care and clinical efficiencies through the creation of dashboards that facilitate customizing data to information and quality improvement needs.

Other software such as VizSweet and StatPlanet were considered for their flexibility and interactive, visual presentations of data across multiple levels. However, we were unable to reach the development team or parent company for VizSweet after repeated attempts and therefore excluded the software from further consideration. StatPlanet, while a strong candidate, was excluded as it is based on Adobe Flash; Flash will not be updated or supported beginning in 2018 and will be phased out by 2020, rendering this application unsustainable in the long term.

Table 1. Software application: example candidates and assessments

Software	Benefits	Limitations	Recommendation
MAGICapp (MAGIC), https://www.magicapp.org	<ul style="list-style-type: none"> • Technical support • Allows drill down • Uses fields, terms and tools common in systematic reviews • Follows popular GRADE methodology • Evidence summaries can be linked to guidelines and decision aids. 	<ul style="list-style-type: none"> • Requires fitting data into software as a guideline or evidence summary, which have different display features • Interventions must be entered separately, rather than taken from a summary table or figure • Limitations on the types of data that can be entered (e.g., negative values are currently not supported) 	Move forward with data mockup and evaluation with OHSU content experts
StatPlanet (StatSilk)	<ul style="list-style-type: none"> • Technical support • Visualization in drill down and slice and dice • Used by academic and health organizations, including universities and the World Health Organization 	<ul style="list-style-type: none"> • Currently based on Flash format, which Adobe is phasing out by 2020, requiring eventual conversion of products into new format • Data are managed in Excel with macros, which increases potential for errors and security risks 	Recommend against selection for this project
Tableau® (Tableau Software), https://www.tableau.com/	<ul style="list-style-type: none"> • Technical support • Visualization in drill down and slice and dice • Features academic and healthcare-focused analytics 	<ul style="list-style-type: none"> • As with MAGICapp, data must be entered separately, in this case into Excel sheets 	Move forward with data mockup and evaluation with OHSU content experts
VIZsweet (Information is Beautiful)	<ul style="list-style-type: none"> • Visualization in drill down and slice and dice 	<ul style="list-style-type: none"> • Currently not available for commercial use • No response from development team or company despite multiple attempts to contact them 	Recommend against selection for this project

Development and Testing of the Dissemination Product

As noted above, we used select data from the chronic pain report¹⁶ to build the examples. Screenshots of the development process are in Appendix C, Figures C1 to C20, while screenshots of the final products tested are shown in Figures C21-22 in the same appendix.

Dissemination Product 1: MAGICapp

The process of creating a new evidence summary is described in detail on the MAGICapp Knowledge Base page (<http://help.magicapp.org/knowledgebase>), and captured via screen shots in Figures C1-C10 in Appendix C. Briefly, we created sections that mirrored the report organization and manually entered report text and data into the appropriate fields on the site. MAGICapp provides a standard template for all users with pre-selected data fields, including section text, population, intervention, outcomes, and comparators. Within the data elements,

there are additional options for study results and timeframes, study measurements, effect estimates, quality of evidence, references, and plain text summaries. As all EPC reports contain this information, this predetermined format can be scaled up for use by other EPCs. In addition, we manually entered references and figures from the report. MAGICapp does have autofill capability for data and references, but this requires the use of Cochrane's RevMan5 data management and reference software. The Pacific Northwest EPC uses EndNote®, which was not compatible with the MAGICapp application programming interface at the time we were developing the prototype. As we were inputting data from a static report into the platform, the bulk of the time in developing the dissemination product was spent in manually transferring data from the report to the Web data entry interface. The volume of text and data differed across key questions, and the chronic pain report data were not formatted in a way that would facilitate seamless transfer to a different file or format.

With these caveats in mind, the time to add section text, data, strength of evidence indicators, and references for a single intervention within a key question varies depending on whether information can be imported directly, as is possible if the systematic review was created using RevMan, the product created by Cochrane, or if data had to be re-entered. For example, to manually enter data that was not prepared for importation into the tool, it took one staff member one full work day to extract, upload, and quality check all data for two interventions. In terms of cost, MAGICapp provides free trials for organizations; for those wishing to use the service beyond the initial trial, MAGICapp has a subscription-pricing model that varies by organization size and for-profit status. MAGICapp adjusts the price based on individual organization income and volume, and therefore we are unable to provide any estimates at this time. Once an evidence summary or guideline is completed in MAGICapp, it is available via that website without cost or login requirements.

Dissemination Product 2: Tableau®

The process of creating a workbook and dashboard in Tableau is described in tutorials on the Tableau site (<https://www.tableau.com/support>) and captured via screen shots in Figures C11-C20 in Appendix C. Briefly, the Microsoft Excel workbook was organized in a relational database format, which best aligns with Tableau's data structure and reduces duplicate data entry. We created three sheets: condition, study, and outcome. The condition sheet included all conditions listed in the report; each row corresponded to a condition, while columns included data for each condition. The study sheet included all studies referenced in report; each row corresponded to a single study, while columns included data for each study. Information included PubMed ID, study headline, intervention category, reference number in the original report, first author and year, quality rating, followup term, and full citation. Finally, the outcomes sheet included all outcomes listed in the report, separated by type of pain (condition), type of intervention, effect (pain versus function), and term of effect (short, intermediate, or long). Each row corresponded to a single, separate outcome; columns corresponded to data on that single outcome, as well as links to the condition and study related to that outcome. Once a workbook is created, researchers are able to share the template with other EPCs, allowing for scalability across centers. However, any changes to the design of the workbook would require additional data manipulation by a staff member with knowledge of informatics or familiarity with the program.

The dashboard, or a collection of Excel sheets, was created in Tableau using Tableau Desktop, as part of a Tableau Creator license. A yearlong, single desktop license was purchased

for \$600. Pricing for Tableau Creator varies based on individual and institutional needs (<https://www.tableau.com/pricing/>). Using the Excel workbook, we first created the summary sheet for the dashboard, which includes the pooled data across multiple studies. The visualization was modeled after a forest plot, which are frequently used in systematic reviews to present the quantitative synthesis of evidence. This was done by combining a Gantt-chart-styled bar chart with a scatter plot along a horizontal axis. Each row, separated vertically, indicated a separate record, in this case an outcome. Outcomes were pooled in a hierarchical order: condition, intervention, comparison, effect, and term of effect. This resulted in a unique record/row for each combination of these elements in the report. We created a pop-up window with detailed text to provide more information for users. This process was then repeated for the individual studies sheet, where no pooling was involved. From this process, we had a record for each outcome from each individual study, where a one-to-many relationship exists between studies and the pooled outcome estimates. Similar to the pooled data, we created a pop-up window for each study to provide further information, including a link to the individual study's PubMed entry. These summary sheets for pooled and unpooled data were combined into a dashboard. Filters for the five levels of factors were added, along with legends for intervention information and sample size. Finally, the Summary section of the dashboard was designed to filter the data in the Studies section, allowing the user to view all individual studies/outcomes associated with a pooled outcome estimate. The design of the dashboard allowed users to see the results across many combinations at once, resulting in the desired ability to “slice and dice” the data into desired pieces.

The dashboard was created with the intention of being viewed on a 1920 x 1080 monitor. The visualization will automatically adjust for different sized monitors, but some details may be obscured. Tableau has built in the ability to set specific views for different sized monitors, including mobile displays. This would allow the report to be optimized on almost any device that could view it, though this was not done during this project. In terms of time, it took one staff member with informatics expertise approximately one day's worth of online training and data cleaning to properly learn the product and develop the first iteration of a worksheet. Future iterations were developed in less than a day.

Final Product Summary

We incorporated data from the chronic pain report into MAGICapp and the Tableau workbook. Specifically, we abstracted data relating to select interventions for chronic low back pain and neck pain from Appendix G of the chronic pain report, in which the strength of evidence tables were presented, and the related forest plots from the main report text. Screenshots of the final pilot products are included in Appendix C; the final products can be accessed online at <https://app.magicapp.org/app#/evidence-summary/150> for MAGICapp and https://public.tableau.com/profile/connor.jp.smith#!/vizhome/AHRQT01MethodsPilot-PacificNorthwestEPCV2_1/NonpharmacologicalInterventionsforPain for Tableau.

Overall, the pilot project took an estimated 300 hours of staff resources, including the background research, evaluating different tools, pre- and post-implementation interviews, and presentations, as well as the time to create the prototypes. This estimate includes project management (90 hours); project setup and evaluation by the core investigator (40 hours), including discussions with MAGICapp and Tableau support teams; data preparation, entry, and review by one EPC staff member and two student workers (150 hours), including learning how

to set up the relational database for Tableau and troubleshooting any issues in product development; and testing and evaluating the dissemination products (20 hours).

More accurate estimates of the actual time required to create these tools as part of a systematic review are needed in order to assess their potential. This could be evaluated in a future pilot test that focuses on the creation and use of one or both approaches as part of the systematic review process.

Evaluation Results

As described in the Methods section, we conducted six short interviews with content experts, including Dr. Crabtree, the original health systems representative (Appendix B). During this time, Dr. Crabtree left OHSU and encouraged us to contact her replacement, Stephanie Halvorson (one of the original panel participants interviewed). Dr. Halvorson, in turn, referred us to Doan Ha and Marcy Hager, responsible for guideline development and implementation through the Office of Clinical Integration and Evidence-based Practice. The other two interviews were with Drs. Lieberman and Larson, both clinicians and members of guideline committees at OHSU. Finally, we presented the pilot results at the annual AHRQ EPC meeting in May 2018 and recruited a number of researchers and staff at our EPC to review the results in order to better understand the perspectives of those preparing data for use in the platforms.

To evaluate the developed product and its expected utility among potential end-users (decision makers in the OHSU health system), we conducted 30- to 60-minute, face-to-face unstructured interviews. During the interviews, Dr. Totten presented the rationale for the project and briefly demonstrated how each product worked. We encouraged the respondent to ask questions throughout the presentation. In addition, we asked each respondent to describe the overall impression of the products and to consider the most appropriate setting or user for each product. Both the initial and evaluation interviews were conducted to understand what decision makers wanted to see in dissemination products and how it should be formatted; in addition, we asked decision makers in the evaluation interviews to make suggestions on how to improve the format we developed (see Table 2 for comparisons of the two tools).

The respondents provided positive feedback on the products, aesthetically as well as for their potential functionality. The primary takeaway from our discussions, as reported by the respondents, was the need for the learning health system administrators to consider the level of expertise of the end users, as those with more or less familiarity with a set of data may require the granularity of MAGICapp or the freedom of Tableau. The themes were the use of the tools together, using MAGICapp for clinicians with less familiarity of a topic and Tableau for clinicians who were experts in their fields, and questions around the amount of time required to both set up and use these tools.

Table 2. Evaluation of MAGICapp and Tableau® as dissemination tools

Software	MAGICapp	Tableau®
Benefits	<ul style="list-style-type: none"> • No back-end work or special expertise needed to set up • Structure matches organization of EPC report, which may be ideal for clinicians less familiar with the topic • Approachable format with capacity for detailed narrative • Provides substantial detail on individual studies • An evidence “ecosystem,” connecting evidence summaries with guidelines and clinical decision models • Collaborates with BMJ, Cochrane, and others • Published reports are free and publicly available, accessible from any location 	<ul style="list-style-type: none"> • Flexible structure, end users can tailor and explore dataset based on their needs – allows clinicians to ask questions in multiple ways • Dashboard updates in real time when data are adjusted or added • Visual format with capacity for minimal text or statistics allows a quick overview of data for content experts • Designs can be shared or used as templates across EPCs • Used by learning healthcare systems for analytics and real-time monitoring • Dashboards are free and publicly available, accessible from any location • Recommends best practices for building data views that conform to the Web Content Accessibility guidelines (WCAG 2.0 AA)
Limitations	<ul style="list-style-type: none"> • Structure is fixed to reflect analysis done in the EPC report • Narrative may still be dense, depending on report contents • Current presentation not as conducive to continuous variables as dichotomous outcomes • Current reference management requires some manual editing, does not allow exports • Uses GRADE methods and criteria, not AHRQ • Potential for conformance to Web Content Accessibility guidelines (WCAG 2.0 AA) is undetermined; the producer is looking into this question 	<ul style="list-style-type: none"> • Expertise needed for set up • Less detail included on individual studies in visual displays • Difficult to display data that does not fit within a conventional format • Limited capacity for narrative content • The application allows the interfaces and displays to be customized, but there are limits to the queries that can be run
Considerations for Future Use	<ul style="list-style-type: none"> • EPCs will have to revise data abstraction and analysis formats to allow for smooth importation • MAGICapp will have to update identified issues relevant to evidence summary publication • AHRQ will need to support EPC investment in MAGICapp to add AHRQ “strength of evidence” criteria to the platform or convert to GRADE criteria 	<ul style="list-style-type: none"> • EPCs will have to revise data abstraction and analysis formats to allow for smooth importation • EPCs may want to consider including separate tabs with guidance on interpreting statistical measures, population characteristics in the study, and strength of evidence ratings • Tableau will have to work with EPCs to develop effective means of communication for unique data formats • AHRQ will need to support EPC investment in data analysts/research staff willing to learn or have experience in designing visualizations of data

Complementary Tools

Clinicians and decision makers have varying levels of skill and expertise when reviewing and interpreting research evidence. A member of the OHSU Clinical Integration and Evidence-based Practice staff noted a benefit to using both MAGICapp and Tableau when presenting data to guideline committees: “I don’t know how clinicians will want to see the data, so this would allow us to customize. You have to speak to everyone in the audience.” A content expert involved in developing colorectal cancer guidelines echoed the benefit of using the two complementary products; MAGICapp would allow for a shared foundation of available evidence, while Tableau would provide investigators the opportunity to formulate specific questions based on their local needs. A Clinical Integration and Evidence-based Practice staff member stated that learning styles and familiarity with a topic could influence the choice of dissemination product: “I love visuals, so I love Tableau. Tableau is more for content experts, a very quick overview of how the data look. But MAGICapp also is useful because it is separated by specific questions, and that’s how I might present it to a guideline committee.”

MAGICapp for Generalists

Respondents, who were health system users, perceived MAGICapp as ideal in assisting multidisciplinary groups develop guidelines, especially as the strength and quality of evidence often varies across studies and these differences affect how clinicians interpret data. One content expert noted, “I can use this to get a 35,000 foot view of the key questions and recommendations, and then it’s relatively easy to drill down.” In particular, the potential connection to recommendations in the MAGICapp platform, as well as the link to individual study abstracts, is perceived to be useful for clinicians looking for general information. A content expert said, “Clinicians want things to be simple. Here is a list of questions, here is a way to expand that, and then the link to PubMed. Being able to look at the abstract and decide for yourself if you think it’s relevant, to dig deeper if you want, is nice.” Another content expert perceived MAGICapp to be useful in general patient care given the structuring the question around a condition first and interventions second, as that follows the structure of the report. The absence of a PICOTS table was noted by one content expert, although he acknowledged the addition of inclusion and exclusion criteria would likely be a preference of content experts and not necessarily expected by non-academic clinicians.

Tableau for Experts

When presenting to content experts, Drs. Crabtree and Halvorson expressed their preferences for Tableau, highlighting the visual graphics across outcomes versus the dense text of the report. Dr. Crabtree noted that Tableau could be valuable for other high-level decision makers as well: “It would make my job easier and be less painful for the physicians. If you’re a hospital administrator and want to know which is better to cover for inpatient services, massage versus acupuncture, you can see that versus trying to find it in the report.” A content expert stated that the ability to explore comparative data based on local needs and questions is an appealing benefit of Tableau, beyond the guideline committee: “I’d want to ask different questions for my patients, for example, to know whether I should consider X or Y intervention, and look at the data in different ways.” Another content expert said Tableau’s search functionality “makes more sense for guideline committees or clinicians; you can ask the question either way.” Finally, one content expert perceived Tableau’s visual format to be more useful for guideline committees, as they are

often accessing data simultaneously from geographically disparate locations; the visualization also may be useful “as a quick way to convince someone of your point” or to facilitate interpretation of data rather than referring to text. However, the respondents noted additional information in pop-up boxes for the studies would be needed to assist clinicians in interpreting statistical measures, highlight specific patient population characteristics that may influence outcomes, and account for the strength of evidence rating.

Required Time Investment

All respondents inquired about the amount of effort needed to prepare and migrate the review data into the platforms, with the consensus among both decision makers and the EPC staff that Tableau appeared more complicated than MAGICapp. A member of the Clinical Integration and Evidence-based Practice staff suggested that adoption of Tableau requires “someone on the team who thinks about how the data are stored, as well as someone who thinks about how the data are presented.” However, a content expert noted, “It makes you wonder how information should be stored going forward. Tableau seems like the most meaningful way to do it, in a way that allows relational exploration.”

While MAGICapp was less front-end intensive, EPC researchers wondered how to account for overlapping studies with multiple interventions in either product, and how to dual-review data abstraction if the end product was sliced and diced. Overall, neither dissemination product fully supported all of the stated needs of researchers or end users, but in the appropriate context, each provided the opportunity for customization and collaboration.

Discussion

Evidence-based Practice Centers (EPCs) conduct large-scale systematic reviews and meta-analyses, producing a substantial amount of data and information that is disseminated in reports, most often via downloads from the AHRQ website of files in Portable Document Format (pdf). These are freely available for use by learning healthcare systems and other end users. Accessing and using these reports in the development of clinical guidelines and protocols may improve patient care and operational efficiency of these systems.⁴⁴ However, while the reports contain useful data to answer clinically and operationally relevant questions for end users, the data are not always easily accessible and are not customizable for local or internal needs.^{38, 45} As the report outputs are text-based and static, the onus is on users at all levels to uncover relevant conclusions, trends, or questions for further research.^{13, 46} Accordingly, these reports may not meet the needs of decision makers. Without accessible, adaptable “off the shelf” evidence, policy and practice—and therefore the quality of patient care—will vary across the country.⁴⁷⁻⁴⁹

The recent Noninvasive Nonpharmacological Treatments for Chronic Pain systematic review illustrates this challenge. The topic is very timely and relevant for many local efforts to develop protocols and improve practice. However, the data were presented from 202 trials covering 5 types of pain, 8 interventions, and 6 potential outcomes in hundreds of pages; the report includes 62 tables and 52 figures. Making this information more user-friendly seems to be a logical approach to increasing its impact.

Utility and Applicability for Other Health Systems

The focus of this report was to test dissemination products for use by decision makers at Oregon Health & Science University. With resolution of Section 508 accessibility and government data rights issues so that future products can be posted on the AHRQ Web site, we hope that other health systems also will be able to use them. The developed prototypes may facilitate learning health systems’ efforts to provide evidence-based, quality care through continuous learning and improvement. Specifically, employing digital formats like MAGICapp and visual interfaces like Tableau[®] may facilitate collection, sharing, and application of evidence and patient experiences to inform patient care and clinician decision making. The interactive products may allow knowledge to be transferred more quickly from dissemination to implementation, and used in the context of local needs and capacity.

Lessons Learned and Utility for Other EPC Reports

The pilot project demonstrated that alternative formats were possible and explored the advantage of developing report formats that could facilitate broader dissemination using broadly available software and platforms (proof-of-concept). These results warrant further exploration and resolution of operational issues related to posting of products on the AHRQ Web site to advance from proof-of-concept to public use. The overarching advantage of alternative formats is that data from a systematic review can be more readily manipulated to locate and display information in ways that reflect the needs and constraints of the user where the data will be applied.³⁹ The benefits and limitations to each of our two tested approaches, from the perspective of our project team, are summarized in Table 2 and discussed below. Awareness of the potential to convert currently static systematic review data into interactive Web-based applications could help shape the future preparation and presentation of data in EPC reports.

Dissemination Product One: MAGICapp

The utility of MAGICapp is the ability to drill down through several layers of data, from an overall evidence summary to individual studies. End users, whether local or national guideline committees or a clinician following a guideline, can access and manipulate the level of evidence summary from overall, through different key questions, down to the level of individual report details.

A key benefit for EPCs situated within learning health systems is the seamless transition from the EPC's evidence summary to the health system's GRADE guideline development and clinical decision models, all within a single platform; a guideline committee could use the evidence summary based on the EPC systematic review and then build the recommendations without having to re-enter the evidence details. For researchers in EPCs, the electronic format is approachable and intuitive, and the ability to collapse or expand sections of the report allows creators and end users to change focus easily. In addition, end users have the ability to move from broad summary outcomes to granular detail. Unlike some data visualization tools, MAGICapp does not obviate the need for text; EPCs can import written content to provide context for, or explanations of, the data. Finally, access to information in MAGICapp is free and available for public use, once creators have published their reports.

There are a number of limitations based on our experience retrofitting a report into MAGICapp; some are inherent to the platform itself, others may be resolved by MAGICapp in future iterations. The main limitation of this drill down approach is its adherence to the original vertical structure of the EPC report. Data are not amenable to analysis outside the structure of the questions and evidence organization of the EPC report. Using the chronic pain report¹⁶ as an example, a clinician can look only at yoga's effect on short-term function as one intervention within the sections on each specific type of pain by flipping back and forth across sections; the user cannot view the effect of an intervention such as yoga on function and pain across different types of pain, such as chronic neck and back pain on one screen.

However, MAGICapp is currently addressing some of the set-up issues we noted, as the platform is still in development. For example, the data entry and generation absolute effect estimates and differences are currently set up for dichotomous variables and specific outcome formats (i.e., odds ratios), whereas results in some evidence summaries, such as the chronic pain review we used, may have outcomes that are continuous variables and reported as means or differences with 95 percent confidence intervals. In addition, the developers set Review Manager 5 as the default manager for importing data and references. When using other reference management systems such as EndNote[®] some details, such as article identifiers (i.e., identification or accession numbers) are lost and must be manually added. Regardless of the system, there currently is no way to code whether imported studies are primary or systematic reviews, nor can end users export or share references.

Finally, MAGICapp was developed based on Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology and criteria, and does not use AHRQ definitions to assess evidence quality and strength of evidence. While creators and end users can map GRADE's "certainty in effect estimates" indicators (risk of bias, inconsistency, indirectness, imprecision, publication bias, and overall certainty level) to AHRQ's "strength of evidence" criteria (study limitations, consistency, directness, precision, reporting bias, and overall strength of evidence), this requires front- and back-end data wrangling and interpretation.

The applicability of MAGICapp for other learning health systems is high, especially for systems that currently integrate evidence dissemination efforts with guideline and protocol

development. An advantage of MAGICapp is that it aspires to be part of an “evidence ecosystem” in which evidence production, dissemination, and use are linked and the tools used for all these activities are compatible. Specifically they have developed or are developing ways to link the evidence summaries and recommendations to decision aids for patients and clinical decision support for clinicians. For reports that are produced using such a different tool, EPCs would need to extract data from existing content, including figures and appendices, if this platform was used after a report was completed. For future reports, EPCs could plan their data organization and formats to facilitate better translation into these formats.

Dissemination Product Two: Tableau

The utility of Tableau is the ability to slice and dice data in ways that are relevant to end users, outside of the structure of the report.

A key benefit for EPCs and learning health systems is the ability to share Tableau designs or templates across teams and centers, reducing the initial effort to set up the data—especially for learning health systems already using Tableau for analytics or patient monitoring. In addition, the structure of data presentation is flexible, allowing end users to tailor datasets to their evolving questions and needs. The visual interface provides an alternate format to longer narrative text reports, with customized options such as tree diagrams or forest plots that are familiar to healthcare providers and researchers. Finally, dashboards, once produced, can be made available without cost for public use. The data and report are owned by the creator, not Tableau, and the creator decides whether to allow end users to download the data.

There are a number of limitations based on our experience creating a new dashboard in Tableau. A limitation of this slice and dice approach is that the level of detail in terms of the number of variables and the amount of explanatory text is not as robust as in MAGICapp or the traditional report format. While creators can add information on quality and links to primary studies, adding too much text or too many pop-up windows could make the end product difficult to use. A general template can be created, but the focus of the dashboard will change based on each project’s design. In addition, if the data has not been stored in relational Excel® databases, initial setup of the data may require data management and Excel database expertise. Tableau relies on an Excel-based/relational data model in order to take full advantage of its potential. EPCs may need to modify current data abstraction and storage practices in evidence tables in order to import the data correctly without re-entry. For example, data would need to be stored in an extractable format, i.e., one datum per field or cell, rather than the current practice of multiple data points and text per cell. Finally, the dashboard is intended for viewing full-screen on a 1080p monitor, which may limit its functionality for those with small screens and without sufficient resolution.

The applicability of Tableau for other learning health systems is high, as is the potential to integrate with internal databases or systems already using the product. Tableau is preferred for high-dimensional reports, allowing for reporting across categories and comparing effectiveness of interventions using customized visualization formats.⁴⁰⁻⁴²

Recommended Next Steps

To continue to evaluate our prototype tools, their potential utility for systematic review end users and their ability to increase the impact of systematic reviews there are several possible next steps.

First, it would be useful to incorporate planning to use one or both of these tools into a systematic review project from the beginning. This could allow for a more realistic assessment of the resources, time and expertise needed to produce these alternative formats, as current estimates reflect the time needed to extract and retrofit data from completed reviews. This experience would allow an informed response to concerns that these formats may be too time-consuming or onerous to produce. It could also inform the scope of work, timelines, and budgets for any projects that wanted to either include these tools as part of their final product, either as a supplement to or replacement for parts of the traditional paper/pdf reports.

Second, issues for further exploration for implementation of data visualization tools include Section 508 accessibility standards and government data rights, as well as potential interoperability with other systematic review tools, such as the Systematic Review Data Repository™.

Finally, additional feedback would be useful from a wider range of potential users and stakeholders. It is possible that the Oregon Health & Science University experts we interviewed are not representative of potential users in other health systems. Also, we did not talk to systematic review producers, except for a brief presentation to other EPC directors and our own staff. It is important to understand and attempt to address any concerns that these formats could compromise the accuracy and quality of the report.

Conclusions

Systematic reviews are critical for the dissemination of rigorous evidence that can be used to inform decisions made in learning health systems. The format of many systematic review reports, including lengthy text, reliance on static data presentations and text, and adherence to one specific structure for key questions can negatively affect usability and impact of these reports. While tools to improve the quality of systematic reviews have been well documented in the literature, there are few studies exploring how novel report formats influence usability and uptake of evidence.

We considered the potential of two existing platforms/software products to improve accessibility, flexibility, and use of systematic review data. Each product had the capability to allow one, but not both, of our target functionality: drill down and slice and dice. Both provide end-users with the ability to customize their experience of the complex data in ways not possible within the format and organization of the original report. Our initial experience and evaluation suggest that both of these approaches could be used to supplement or augment Evidence-based Practice Center reports, and both products were well received by potential end users.

We recommend future expanded evaluation studies be conducted to assess whether these types of dissemination products can increase uptake of EPC reports within learning health systems. Specifically, given that neither tool provides both “drill down” and “slice and dice” alone, we recommend that the tools be incorporated into future proposals to allow EPCs to assess time and financial investment in preparing and managing data and incorporating the tools into their report. Additionally, we recommend further investigation on how to make products built with such tools available to the public via the AHRQ Web site, including concerns regarding Section 508 accessibility, government data rights, and interoperability with other systematic review tools. With “real world” assessments, EPCs will be able to recommend the use of one or both tools, or determine the need to explore additional existing software for more options. In addition to uptake and comprehension, we recommend future researchers consider ways to evaluate whether novel products contribute to improved quality care within learning health systems.

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Appendix A. Health System Representative Participation

From: Elizabeth Crabtree
To: [Elaine Graham](#)
Cc: [Annette Totten](#)
Subject: RE: EPC methods/dissemination
Date: Monday, October 09, 2017 4:10:42 PM

Hi Elaine,

Great seeing you today! I'm looking forward to working with you to develop a dissemination product related to a selected EPC report, and am excited to use it across the health system as we implement local evidence-based guidelines.

Many thanks for the invite to participate! Elizabeth

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Appendix B. Needs Assessment Questionnaire, Interview Summary, and Stakeholders

Questionnaire

1. What is your current title/role?
2. Overall, describe your experience developing the OHSU guideline [insert relevant topic].
 - a. What worked well?
 - b. What were some challenges?
3. What sources of evidence did you and the group use when developing this guideline?
4. What format was the evidence in that you used for guideline “X”? E.g., formal report, journal articles, systematic review, or other guidelines?
 - a. What is the typical length of this format?
 - b. What made the evidence easy to use?
 - c. What made the evidence difficult to use?
5. If you were to do another guideline, how could the evidence be organized or formatted to be more useful?
6. Are you familiar with the AHRQ EPC reports?
 - a. If yes, were they useful and how could they be changed to be more useful?
Thank you for your time and participation.
 - b. If no, thank you for your time and participation.

Interview Summary

To gain insight into the guideline development process, we interviewed four out of six physicians who participated developing guidelines for Oregon Health and Science University. The individuals previously served as the content experts on the OHSU’s guideline development teams for Cystic Fibrosis, Supplemental Feeding in Neonates Guideline, and Colorectal Cancer Screening. We conducted short open-ended interviews about their experiences to determine what was helpful developing guidelines and if there were areas that could be improved.

Overall, each of the interviewed content experts has a positive experience developing their guidelines for OHSU. All of the interviewees highlighted well-prepared literature reviews and evidence summaries as part of their experience. Three of four interviewees commented on the organization of the guideline team and effective communication across multiple stakeholders. The thoroughness of the research and the summary of information were mentioned as strengths across the board.

Certain barriers affected particular guidelines more than others did. Both content experts interviewed for the Cystic Fibrosis Guideline mentioned a lack of resources on cystic fibrosis as a problem. The concern was partially mitigated by borrowing evidence from relevant treatments or drawing information from similar studies. One interviewee mentioned the density of some of the literature as a barrier. Two interviewees expressed coordination and the implementation of the guideline as barriers. Not all members were present at every meeting and no patients were involved in guideline development.

Three out of four interviewees said the evidence sources they used for the guideline development were previously developed guidelines. They commented that they used previous guidelines, prior literature and professional opinions. One interviewee noted that the group agreed not to revisit all the prior literature and did not want to “reinvent the wheel.”

Interviewees reported that evidence from randomized control trials, cohort studies and types of evidence were presented in tables and summary format. One interviewee stated that information was displayed on PowerPoint slides. Evidence was presented in a handout that summarized existing guidelines. This was praised as it allowed a baseline for team members who did not have much experience with guideline development. The GRADE format was mentioned by one reviewer as being helpful for both assessing and developing his or her own guideline.

Two interviewees also mentioned the use of PICOS questions to organize information pertinent to their guidelines. One interviewee stated the PICOS questions were useful because, “they were questions I had not thought to ask” while another stated that PICO questions were adopted and the literature was reviewed to answer them.

One complaint about the evidence was for Cystic Fibrosis. The content expert felt that there was not a lot of information and that the evidence did not always apply to the population. They also commented that the document was 49 pages long and not everyone was available to pre-review the literature. Another content expert opined, “There was a lot of evidence.” The reviewer recommended a prescreening of evidence limit or narrow focus.

When asked about what could be done to change the format and presentation of evidence for future guideline development meetings, one of the four interviewees was satisfied with the way information was presented and recommended no changes. The other two interviewees recommended changes to the way the information was presented. One interviewee wanted a, “different way to visualize the information, color coding for good studies” and studies to be limited to “studies with relevance.” Additionally one interviewee suggested that the format should continue to use good PICO questions and stay effective and efficient. One content expert reported that they were very familiar with Evidence-based Practice Center reports; one reported they “sounded familiar” and two stated they were not familiar with A Evidence-based Practice Center reports.

Stakeholders

Elizabeth Crabtree, Ph.D., M.P.H., Director (former), OHSU Office of Clinical Integration and Evidence-Based Practice

Doan Ha, Dr.P.H., M.P.H., Guideline Implementation Manager, OHSU Office of Clinical Integration and Evidence-based Practice

Marcy Hager, M.A., Guideline Development Program Manager, OHSU Office of Clinical Integration and Evidence-based Practice

Stephanie Halvorson, M.D., Interim Director, OHSU Office of Clinical Integration and Evidence-Based Practice

Ilse Larson, M.D., Department of Pediatrics, OHSU Practice Plan committee member

David Lieberman, M.D., Department of Gastroenterology and Hepatology, OHSU Practice Plan committee member

Appendix C. Screenshots of Dissemination Product

Screenshots of MAGICapp product development

Figure C1. Creating report sections in MAGICapp



Figure C2. Inserting section text from the report

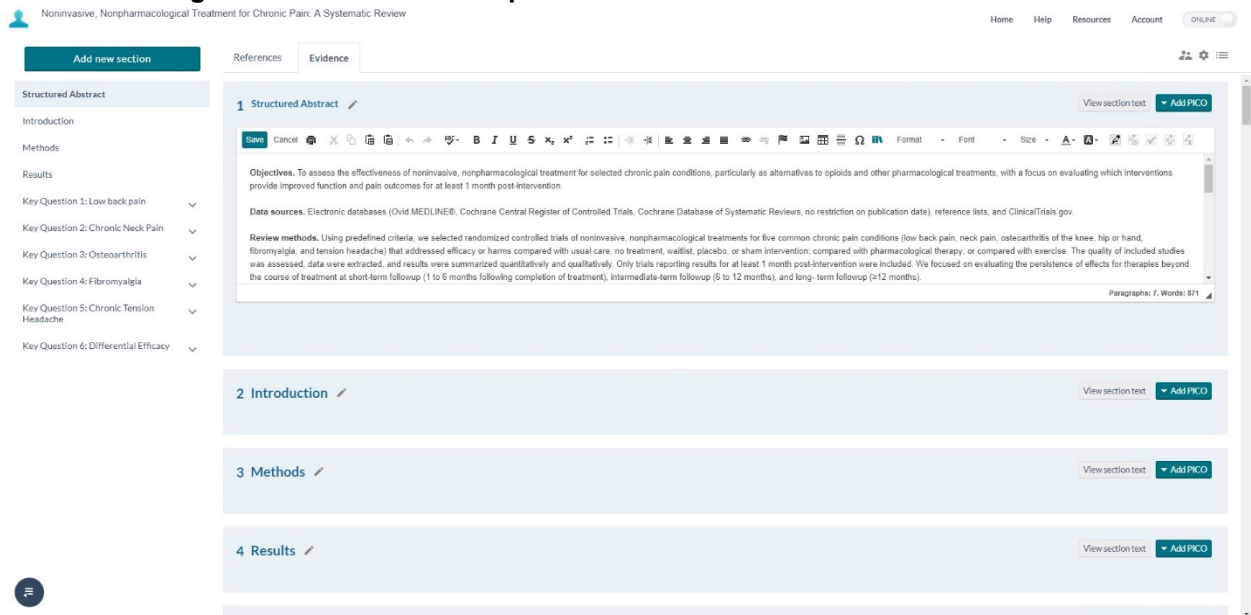


Figure C3. Adding Key Question outcomes

The screenshot shows the 'Evidence' tab in a software interface for a systematic review. The main section is titled '5.1.1 Exercise' and contains a table with columns for 'Outcome Timeframe', 'Study results and measurements', 'Absolute effect estimates', 'Certainty in effect estimates (Quality of evidence)', and 'Plain text summary'. The 'Outcome Timeframe' column shows 'Function (Short-term)'. The 'Study results and measurements' column shows 'Based on data from 553 patients in 6 studies'. The 'Absolute effect estimates' column shows 'Difference: 0.31 lower (SMD) (CI 95% 0.58 lower - 0.04 lower)'. The 'Certainty in effect estimates' column shows 'Low' with a note: 'Due to serious risk of bias and inconsistency'. The 'Plain text summary' column shows 'Exercise was associated with slighter greater effects on short-term function'. Below the table, there are fields for 'Outcome Short Name (Shown in Tables)', 'Outcome', 'Timeframe of Estimates', 'Clinical Importance of Outcome', 'Mesh Term', and 'Mesh Code'. A 'Save' button is visible at the bottom right of the table area.

Figure C4. Creating the evidence profile

The screenshot shows the 'Evidence' tab in the same software interface. The main section is titled 'Function (Intermediate-term)' and contains a table with columns for 'Outcome Timeframe', 'Study results and measurements', 'Absolute effect estimates', 'Certainty in effect estimates (Quality of evidence)', and 'Plain text summary'. The 'Outcome Timeframe' column shows 'Function (Intermediate-term)'. The 'Study results and measurements' column shows 'Based on data from 1091 patients in 3 studies'. The 'Absolute effect estimates' column shows 'Difference: 0.09 lower (SMD) (CI 95% 0.24 lower - 0.06 higher)'. The 'Certainty in effect estimates' column shows 'Low' with a note: 'Due to serious risk of bias. Due to serious inconsistency. Due to serious imprecision. Due to serious publication bias'. The 'Plain text summary' column shows 'There was no effect on intermediate-term function'. Below the table, there are several sections: 'Measurement type, scale and label of units' with fields for 'Measurement Instrument', 'Range of Scale (if Relevant)', and 'Label of Units Measured'; 'Expected difference and best estimate of effect with intervention: Massage' with fields for 'Source of Evidence', 'Data from Included Studies', and 'Absolute Difference Intervention vs. Comparator (from Studies)'; and 'Included Studies' with a table listing studies.

Name	Duration of follow up	# total participants	# intervention events	# intervention participants	# control events	# control participants	Weight %
[10] Chenkin 2001	52 weeks	202		172		90	
[11] Chenkin 2011	52 weeks	386		280		116	
[17] Little 2008	52 weeks	462		402		80	

Figure C5. Assessing the certainty of effects (strength of evidence)

The screenshot shows the 'Evidence' page in a systematic review software. The main content area is titled 'Certainty in Effect Estimates' and contains a table of references. Below the table, there are two main steps for assessing certainty:

- Step 1: Are the studies you took results from randomized?** This step involves selecting a study type from a dropdown menu. A note indicates that the GRADE starting point for certainty in effect estimate resides upon the study type the estimates were taken from. Randomized trials start with high certainty, while observational (non-randomized) trials start with low certainty.
- Step 2: Factors that might cause rating down your certainty** This step involves indicating in which areas where you find issues. You can indicate areas as problematic without having to rate down. It just helps you to keep track of judgements. The most important rule is to be transparent. When you tick off an item, a standard text suggestion will be added to the comment box. This step is divided into three sections:
 - RISK OF BIAS:** Includes a dropdown for 'Serious' and a 'PROBLEM AREAS' section with checkboxes for 'The 6 Cochrane RoB items': Sequence (Randomization), Concealment, Blinding of participants/ personnel, Incomplete data, Selective outcome reporting, No intention-to-treat, Carryover effects, Stopped study, Unvalidated measures, and Other issue.
 - INCONSISTENCY:** Includes a dropdown for 'Serious' and a 'PROBLEM AREAS' section with checkboxes for 'Point estimates vary widely', 'CI's not overlapping', 'Direction not consistent', 'Statistical heterogeneity', and 'Other issue'.
 - INDIRECTNESS:** Includes a dropdown for 'No serious' and a 'PROBLEM AREAS' section with checkboxes for 'Population dissimilarity', 'Outcome dissimilarity', 'No direct comparison', 'Intervention/ comparator dissimilarity', 'Time frame insufficient', and 'Other issue'.
 - IMPRECISION:** Includes a dropdown for 'No serious' and a 'PROBLEM AREAS' section with checkboxes for 'Wide confidence intervals' and 'Only one study'.

The interface also includes a sidebar on the left with navigation options and a top navigation bar with 'Home', 'Help', 'Resources', 'Account', and 'ONLINE' buttons.

Figure C6. Inserting the plain text summary

The screenshot shows the 'Evidence' page in a systematic review software, focusing on the 'Summary' section. The main content area displays a table of outcomes with columns for 'Timeframe', 'Quality of evidence', and 'Plain text summary'. The 'Function (Short-term)' outcome is highlighted, showing a difference of 0.31 lower (SMD) with a 95% CI of 0.50 lower to 0.04 lower. The quality of evidence is 'Low'. The plain text summary is 'Exercise was associated with slighter greater effects on short-term function'. Below the table, there is a 'Suggested standard phrases' section with a grid of phrases based on effect size and certainty.

Find suggested phrases in crosspoint between effect size and certainty		Important benefit/ harm	Less important benefit/ harm	No important benefit/ harm or null effect
High	Improves or worsen (all increase or reduce)	Slightly improve or worsen (all, slightly increase or reduce)	Little or no difference	
Moderate	Probably improve or worsen (all, probably increase or reduce)	Probably slightly improve or worsen (all, probably slightly increase or reduce)	Probably little or no difference	
Low	May improve or worsen (all, may increase or reduce)	May slightly improve or worsen (all, may slightly increase or reduce)	May have little or no difference	
Very Low	We are uncertain whether [intervention] improves or worsen (increases/ reduces) [outcome]			
No / rare events	There were too few who experienced the [outcome], to determine whether [intervention] made a difference			
No studies	No studies were found that looked at [outcome]			

The interface also includes a sidebar on the left with navigation options and a top navigation bar with 'Home', 'Help', 'Resources', 'Account', and 'ONLINE' buttons.

Figure C7. Adding the Key Question's summary text and forest plots from the report

function (1 trial, difference 0.00, 95% CI -11.4 to 11.4 on the ODI) [2]

Exercise was associated with greater effects on short-term pain than usual care, an attention control, or a placebo intervention (6 trials, pooled difference -0.81 on a 0 to 10 scale, 95% CI - 1.26 to -0.36, I2=0%) (Figure 5) [1-6] There were no clear differences in estimates when analyses were stratified according to the type of exercise (difference -0.52, 95% CI -1.41 to 0.36 in 2 trials of neuromuscular re-education exercises, -1.12, 95% CI -2.28 to -0.14 in 2 trials of muscle performance exercises, and -0.90, 95% I -2.63 to 0.68 in 2 trials of combined exercises) the type of control (usual care, attention control, or placebo intervention) and when the poor-quality trial was excluded. For intermediate-term pain (3 trials, pooled difference -1.37, 95% CI -2.10 to -0.65, I2=34%) [1-3] and long-term pain (1 trial, difference -1.55, 95% CI -2.78 to -0.32) [2] effects of exercise on pain were moderate, but findings were based on small numbers of trials.

Data on effects of exercise on quality of life were limited. One trial [2] found no differences between exercise versus an attention control on the Nottingham Health Profile at short-term, intermediate-term, or long-term follow-up, and one trial [6] found exercise associated with higher scores on the SF-36 physical functioning (difference 5.8 points on a 100 scale, p=0.026), bodily pain (difference 8.3 points, p=0.03), and vitality subscales (difference 5.3 points, p=0.029) at short-term follow-up; there were no differences on other SF-36 subscales.

No trial evaluated effects of exercise on use of opioid therapies or health care utilization. There was insufficient evidence to determine effects of duration of exercise therapy or number of sessions on outcomes.

Exercise Compared With Pharmacological Therapy
No trial of exercise versus pharmacological therapy met inclusion criteria.

Exercise Compared With Other Non-pharmacological Therapies
Findings for exercise versus other nonpharmacological therapies are addressed in the sections for other nonpharmacological therapies.

Harms
Harms were not reported in most trials. One trial [1] found no difference between exercise and a placebo intervention (detuned diathermy) in likelihood of increased pain, and another trial [29] reported no adverse events.

Figure 4. Exercise versus usual care, an attention control, or a placebo intervention: effects on function

Study, Year	Comparison	Exercise Intervention	Scale	Duration of Follow-up (Months)	Control N, Mean (SE)	Exercise N, Mean (SE)	SMD (95% CI)
Short-term Costa, 2009	Placebo	motor control	RDQ (0-24)	4	77, 12.2 (6.7)	77, 10.3 (7.0)	-0.38 (-0.59, -0.16)

Figure C8. Adding studies and study abstracts

5 Key Question 1: Low back pain

5.1 Exercise

1 PRIMARY STUDY
Goldby L.J, Moore AP, Doust, JO et al : A randomized controlled trial investigating the efficiency of musculoskeletal physiotherapy on chronic low back disorder. Spine 2006;31(10):1063-93- PubMed

Abstract About Results Comments Discussion Places used

STUDY DESIGN : Randomized, single blind, controlled trial. OBJECTIVE : To determine the efficacy of 2 components of musculoskeletal physiotherapy on chronic low back disorder. SUMMARY OF BACKGROUND DATA : Musculoskeletal physiotherapy encompasses many treatment methods, however, manual therapy and exercises to rehabilitate spinal stabilization are the most frequently used. Despite their popularity, scant evidence supports their use on subjects with chronic low back disorder. METHODS : A total of 348 subjects were randomized to manual therapy, a 10-week spinal stabilization rehabilitation program, or a minimal intervention control group. Data were collected at baseline, and 3, 6, 12, and 24 months after intervention. Outcome measures recorded intensity of low back pain, disability, handicap, medication, and quality of life. There were 4 main variables combined in a primary component analysis to form a single outcome measure (i.e., a measure of dysfunction). RESULTS : The results indicated statistically significant improvements in favor of the spinal stabilization group at the 6-month stage in pain (65.9% reduction in symptoms) and dysfunction (combined mean reduction of 134, standard error 23.84), and at the 1-year stage in medication (24.3% reduction in medication), dysfunction (combined mean reduction of 134, standard error 18.2), and disability (mean difference in change 15.71 Oswestry Disability Index, 95% confidence interval 19.3-10.01). CONCLUSIONS : As a component of musculoskeletal physiotherapy, the spinal stabilization program is more effective than manually applied therapy or an education booklet in treating chronic low back disorder over time. Both manual therapy and the spinal stabilization program are significantly effective in pain reduction in comparison to an active control. To our knowledge and up until now, this result has not been shown in patients with chronic low back disorder.

Figure C9. Assigning references to each Key Question

The screenshot shows the 'References' tab for section 5.1 Exercise. The interface includes a sidebar with navigation options, a top navigation bar, and a main content area with a table of references.

Selected	Title
<input checked="" type="checkbox"/>	[1] Goldby LJ, Moore AP, Doust JO et al : A randomized controlled trial investigating the efficiency of musculoskeletal physiotherapy on chronic low back disorder. Spine 2006;31(10):1083-93- Pubmed
<input checked="" type="checkbox"/>	[2] Costa LOP, Maher CG, Latimer J et al : Motor control exercise for chronic low back pain: a randomized placebo-controlled trial. Physical therapy 2009;89(12):1275-86- Pubmed Journal
<input checked="" type="checkbox"/>	[3] Kankaanpää M, Taimela S, Airaksinen O et al : The efficacy of active rehabilitation in chronic low back pain. Effect on pain intensity, self-experienced disability, and lumbar fatigueability. Spine 1999;24(10):1034-42- Pubmed
<input checked="" type="checkbox"/>	[4] Miyamoto GC, Costa LOP, Galvanin T et al : Efficacy of the addition of modified Pilates exercises to a minimal intervention in patients with chronic low back pain: a randomized controlled trial. Physical therapy 2013;93(3):310-20- Pubmed Journal
<input checked="" type="checkbox"/>	[5] Nassif H, Brosset N, Guillaume M et al : Evaluation of a randomized controlled trial in the management of chronic lower back pain in a French automotive industry: an observational study. Archives of physical medicine and rehabilitation 2011;92(12):1927-1936 e4- Pubmed Journal
<input checked="" type="checkbox"/>	[6] Nalour J, Cazotti LDA, Ribeiro LH et al : Pilates improves pain, function and quality of life in patients with chronic low back pain: a randomized controlled trial. Clinical rehabilitation 2015;29(1):59-68- Pubmed Journal

Figure C10. Publishing the evidence summary

The screenshot shows the 'Evidence' tab for section 5.1 Exercise. The interface includes a sidebar with navigation options, a top navigation bar, and a main content area with a table of references.

Selected	Title
<input checked="" type="checkbox"/>	[1] Goldby LJ, Moore AP, Doust JO et al : A randomized controlled trial investigating the efficiency of musculoskeletal physiotherapy on chronic low back disorder. Spine 2006;31(10):1083-93- Pubmed
<input checked="" type="checkbox"/>	[2] Costa LOP, Maher CG, Latimer J et al : Motor control exercise for chronic low back pain: a randomized placebo-controlled trial. Physical therapy 2009;89(12):1275-86- Pubmed Journal
<input checked="" type="checkbox"/>	[3] Kankaanpää M, Taimela S, Airaksinen O et al : The efficacy of active rehabilitation in chronic low back pain. Effect on pain intensity, self-experienced disability, and lumbar fatigueability. Spine 1999;24(10):1034-42- Pubmed
<input checked="" type="checkbox"/>	[4] Miyamoto GC, Costa LOP, Galvanin T et al : Efficacy of the addition of modified Pilates exercises to a minimal intervention in patients with chronic low back pain: a randomized controlled trial. Physical therapy 2013;93(3):310-20- Pubmed Journal
<input checked="" type="checkbox"/>	[5] Nassif H, Brosset N, Guillaume M et al : Evaluation of a randomized controlled trial in the management of chronic lower back pain in a French automotive industry: an observational study. Archives of physical medicine and rehabilitation 2011;92(12):1927-1936 e4- Pubmed Journal
<input checked="" type="checkbox"/>	[6] Nalour J, Cazotti LDA, Ribeiro LH et al : Pilates improves pain, function and quality of life in patients with chronic low back pain: a randomized controlled trial. Clinical rehabilitation 2015;29(1):59-68- Pubmed Journal

MAGICapp Pilot Project URL:

Screenshots of Tableau® product development

Figure C11. Setting up the condition sheet in the workbook

ConditionID	ConditionName	Location	TemporalFactor
COND01	Chronic Low Back Pain	Low Back	Chronic
COND02	Chronic Neck Pain	Neck	Chronic
COND03	Osteoarthritis of the Knee	Knee	Chronic
COND04	Osteoarthritis of the Hip	Hip	Chronic
COND05	Osteoarthritis of the Hand	Hand	Chronic
COND06	Fibromyalgia	General	Chronic
COND07	Chronic Tension Headache	Head	Chronic

Figure C12. Setting up the studies sheet in the workbook

StudyID	PubMedID	PubMedURL	StudyName	InterventionCategories	RefNumber	StudyQuality	First Author	Year	FollowUp	FullCitation
STUD008	19803556	https://www.ncbi.nlm.nih.gov/pubmed/19803556	Motor control exercise for chronic low back Exercise	Exercise	28	Fair	Costa LO	2009	4 10	Costa LO, Maher CG, Latimer J, et al. Motor control exercise for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2009;34(10):1053-61.
STUD009	16648741	https://www.ncbi.nlm.nih.gov/pubmed/16648741	A randomized controlled trial investigating Exercise	Exercise	29	Fair	Goldby LJ	2006	3 6 12 24	Goldby LJ, Moore AP, Doust J, et al. A randomized controlled trial investigating the efficacy of active rehabilitation in chronic low back pain. <i>Spine (Phila Pa 1976)</i> . 2006;31(6):612-20.
STUD032	23064732	https://www.ncbi.nlm.nih.gov/pubmed/23064732	Efficacy of the addition of modified Pilates Exercise	Exercise	32	Fair	Miyamoto GC	2013	4.5	Miyamoto GC, Costa LO, Galvanin T, et al. Efficacy of the addition of modified Pilates to a randomized controlled trial of exercise for chronic low back pain. <i>Spine (Phila Pa 1976)</i> . 2013;38(10):1053-61.
STUD031	22132329	https://www.ncbi.nlm.nih.gov/pubmed/22132329	Evaluation of a randomized controlled trial Exercise	Exercise	33	Poor	Nassif H	2011	4	Nassif H, Brosset N, Guillaume M, et al. Evaluation of a randomized controlled trial of exercise for chronic low back pain. <i>Spine (Phila Pa 1976)</i> . 2011;36(10):1053-61.
STUD033	24965957	https://www.ncbi.nlm.nih.gov/pubmed/24965957	Pilates improves pain, function and quality of life Exercise	Exercise	33	Fair	Natoraj J	2015	3	Natoraj J, Casotti Lda A, Ribeiro LH, et al. Pilates improves pain, function and quality of life in chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2015;40(10):1053-61.
STUD196	9788075	https://www.ncbi.nlm.nih.gov/pubmed/9788075	Controlled trial of Japanese acupuncture Acupuncture	Acupuncture	196	Poor	Birch S	1998	3	Birch S, Jamison RN. Controlled trial of Japanese acupuncture for chronic low back pain. <i>Spine (Phila Pa 1976)</i> . 1998;23(19):2000-6.
STUD217	24171895	https://www.ncbi.nlm.nih.gov/pubmed/24171895	Acupuncture with non-steroidal anti-inflammatory drugs Acupuncture	Acupuncture	217	Poor	Cho JH	2014	1	Cho JH, Nam DH, Kim KT, et al. Acupuncture with non-steroidal anti-inflammatory drugs for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2014;39(10):1053-61.
STUD197	28715459	https://www.ncbi.nlm.nih.gov/pubmed/28715459	Efficacy of abdominal acupuncture for neck pain Acupuncture	Acupuncture	197	Fair	Ho LF	2017	1	Ho LF, Lin ZX, Leung AWN, et al. Efficacy of abdominal acupuncture for neck pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2017;42(10):1053-61.
STUD198	21195292	https://www.ncbi.nlm.nih.gov/pubmed/21195292	Assessment of a traditional acupuncture Acupuncture	Acupuncture	198	Fair	Liang Z	2011	3	Liang Z, Zhu X, Yang X, et al. Assessment of a traditional acupuncture for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2011;36(10):1053-61.
STUD180	26524571	https://www.ncbi.nlm.nih.gov/pubmed/26524571	Alexander Technique Lessons or Acupuncture Acupuncture	Acupuncture	180	Fair	MacPherson H	2015	1 7	MacPherson H, Tilbrook H, Richmond S, et al. Alexander Technique Lessons or Acupuncture for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2015;40(10):1053-61.
STUD189	20576648	https://www.ncbi.nlm.nih.gov/pubmed/20576648	Efficacy of acupuncture in patients with chronic low back pain Acupuncture	Acupuncture	189	Fair	Sahin N	2010	3	Sahin N, Ozcan E, Sezen V, et al. Efficacy of acupuncture in patients with chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2010;35(10):1053-61.
STUD200	16934402	https://www.ncbi.nlm.nih.gov/pubmed/16934402	Efficacy and safety of acupuncture for chronic low back pain Acupuncture	Acupuncture	200	Fair	Vas J	2006	6	Vas J, Perea-Milla E, Mendez C, et al. Efficacy and safety of acupuncture for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2006;31(6):612-20.
STUD201	15611488	https://www.ncbi.nlm.nih.gov/pubmed/15611488	Acupuncture versus placebo for the treatment of chronic low back pain Acupuncture	Acupuncture	201	Fair	White P	2004	2 6 12	White P, Lewith G, Prescott P, et al. Acupuncture versus placebo for the treatment of chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2004;29(10):1053-61.
STUD202	24475889	https://www.ncbi.nlm.nih.gov/pubmed/24475889	Long-term efficacy of electroacupuncture Acupuncture	Acupuncture	202	Fair	Zhang SP	2013	3 6	Zhang SP, Chiu TT, Chiu SN. Long-term efficacy of electroacupuncture for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2013;38(10):1053-61.
STUD090	17621203	https://www.ncbi.nlm.nih.gov/pubmed/17621203	Active exercise, education, and cognitive behavioral therapy Psychological Therapies	Psychological Therapies	90	Fair	Johnson RE	2007	6 12	Johnson RE, Jones GT, Wiles NJ, et al. Active exercise, education, and cognitive behavioral therapy for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2007;32(10):1053-61.
STUD091	20182941	https://www.ncbi.nlm.nih.gov/pubmed/20182941	Group cognitive behavioral treatment for Psychological Therapies	Psychological Therapies	91	Fair	Lamb SE	2010	4.5 10 15 34	Lamb SE, Hansen Z, Lall R, et al. Group cognitive behavioral treatment for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2010;35(10):1053-61.
STUD092	22228729	https://www.ncbi.nlm.nih.gov/pubmed/22228729	Group cognitive behavioral interventions Psychological Therapies	Psychological Therapies	92	Fair	Lamb SE	2012	4.5 10 15 35	Lamb SE, Mistry D, Lall R, et al. Group cognitive behavioral interventions for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2012;37(10):1053-61.
STUD104	2147702	https://www.ncbi.nlm.nih.gov/pubmed/2147702	Effectiveness of behavioral therapy for chronic low back pain Psychological Therapies	Psychological Therapies	104	Poor	Turner JA	1990	6 12	Turner JA, Clancy S, McGuade KJ, et al. Effectiveness of behavioral therapy for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 1990;15(10):1053-61.
STUD160	21622028	https://www.ncbi.nlm.nih.gov/pubmed/21622028	Supervised exercise, spinal manipulation, Manual Therapies	Manual Therapies	160	Fair	Bronfort G	2011	4 9	Bronfort G, Maiers M, Evans RL, et al. Supervised exercise, spinal manipulation, and manual therapies for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2011;36(10):1053-61.
STUD161	17250965	https://www.ncbi.nlm.nih.gov/pubmed/17250965	Comparison of general exercise, motor control, Manual Therapies	Manual Therapies	161	Fair	Ferreira ML	2007	4 10	Ferreira ML, Ferreira PH, Latimer J, et al. Comparison of general exercise, motor control, manual therapy, and a combination of these interventions for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2007;32(10):1053-61.
STUD119	2860453	https://www.ncbi.nlm.nih.gov/pubmed/2860453	Controlled comparison of short-wave diathermy Manual Therapies	Manual Therapies	119	Poor	Gilison T	1985	1 3	Gilison T, Graham R, Harkness J, et al. Controlled comparison of short-wave diathermy and manual therapy for chronic low back pain. <i>Spine (Phila Pa 1976)</i> . 1985;10(10):1053-61.
STUD162	16341712	https://www.ncbi.nlm.nih.gov/pubmed/16341712	A randomized clinical trial and subgroup analysis Manual Therapies	Manual Therapies	162	Fair	Gudavalli MR	2006	2 5 11	Gudavalli MR, Cambon JA, McGregor M, et al. A randomized clinical trial and subgroup analysis of manual therapy for chronic low back pain. <i>Spine (Phila Pa 1976)</i> . 2006;31(10):1053-61.
STUD144	24139233	https://www.ncbi.nlm.nih.gov/pubmed/24139233	Dose-response and efficacy of spinal manipulation Manual Therapies	Manual Therapies	144	Fair	Haas M	2014	4 10.5	Haas M, Vavrek D, Peterson D, et al. Dose-response and efficacy of spinal manipulation for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2014;39(10):1053-61.
STUD145	15359115	https://www.ncbi.nlm.nih.gov/pubmed/15359115	A randomized controlled trial comparing 2 Manual Therapies	Manual Therapies	145	Fair	Hondras MA	2009	1.5 4.5	Hondras MA, Long CR, Cao Y, et al. A randomized controlled trial comparing two manual therapy interventions for chronic low back pain. <i>Spine (Phila Pa 1976)</i> . 2009;34(10):1053-61.
STUD146	21245790	https://www.ncbi.nlm.nih.gov/pubmed/21245790	Does maintained spinal manipulation therapy Manual Therapies	Manual Therapies	146	Poor	Senna MK	1976	3 6 9	Senna MK, Machaly SA. Does maintained spinal manipulation therapy for chronic low back pain? A randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 1976;1(10):1053-61.
STUD147	1556955	https://www.ncbi.nlm.nih.gov/pubmed/1556955	United Kingdom back pain exercise and manual therapy Manual Therapies	Manual Therapies	147	Fair	UK BEAM Trial Team	2004	9	UK BEAM Trial Team. United Kingdom back pain exercise and manual therapy for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2004;29(10):1053-61.
STUD148	24723759	https://www.ncbi.nlm.nih.gov/pubmed/24723759	Effectiveness of myofascial release in the Manual Therapies	Manual Therapies	148	Fair	Ajimsa MS	2014	1	Ajimsa MS, Daniel B, Chittler S. Effectiveness of myofascial release in chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2014;39(10):1053-61.
STUD149	11322842	https://www.ncbi.nlm.nih.gov/pubmed/11322842	Randomized trial comparing traditional Chinese Manual Therapies/Acupuncture	Acupuncture	149	Fair	Cherkin DC	2011	10.5	Cherkin DC, Eisenberg D, Sherman KJ, et al. Randomized trial comparing traditional Chinese medicine, acupuncture, and a combination of these interventions for chronic low back pain. <i>Spine (Phila Pa 1976)</i> . 2011;36(10):1053-61.
STUD150	21727288	https://www.ncbi.nlm.nih.gov/pubmed/21727288	A comparison of the effects of 2 types of Manual Therapies/Acupuncture	Acupuncture	150	Fair	Cherkin DC	2001	9.5	Cherkin DC, Sherman KJ, Kahn J, et al. A comparison of the effects of two types of manual therapy interventions for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2001;26(10):1053-61.
STUD159	18713809	https://www.ncbi.nlm.nih.gov/pubmed/18713809	Randomised controlled trial of Alexander's Manual Therapies	Manual Therapies	159	Fair	Little P	2008	10.5	Little P, Lewith G, Webley F, et al. Randomised controlled trial of Alexander's technique for chronic low back pain. <i>Spine (Phila Pa 1976)</i> . 2008;33(10):1053-61.
STUD093	17459741	https://www.ncbi.nlm.nih.gov/pubmed/17459741	A randomised controlled study of reflexology Psychological Therapies/Exercise/Manual Therapies	Psychological Therapies/Exercise/Manual Therapies	93	Fair	Poole H	2007	4.5	Poole H, Glenn S, Murphy P. A randomised controlled study of reflexology, exercise, and manual therapy for chronic low back pain. <i>Spine (Phila Pa 1976)</i> . 2007;32(10):1053-61.
STUD151	18346022	https://www.ncbi.nlm.nih.gov/pubmed/18346022	Reflexology in the management of low back pain Manual Therapies	Manual Therapies	151	Fair	Quinn F	2008	1.5 3	Quinn F, Hughes CM, Baxter GD. Reflexology in the management of low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2008;33(10):1053-61.
STUD164	26170592	https://www.ncbi.nlm.nih.gov/pubmed/26170592	Effectiveness of mindfulness meditation c Mindfulness-Based Stress Reduction/P	Psychological Therapies	164	Poor	Banath S	2015	1	Banath S, Ardebilli MD. Effectiveness of mindfulness meditation on pain and disability in chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2015;40(10):1053-61.
STUD089	27002445	https://www.ncbi.nlm.nih.gov/pubmed/27002445	Effect of Mindfulness-Based Stress Reduction Mindfulness-Based Stress Reduction/P	Psychological Therapies	89	Fair	Cherkin DC	2012	4.5 10 22	Cherkin DC, Sherman KJ, Balderson BH, et al. Effect of mindfulness-based stress reduction for chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2012;37(10):1053-61.
STUD168	20021599	https://www.ncbi.nlm.nih.gov/pubmed/20021599	A mind-body program for older adults with Mindfulness-Based Stress Reduction	Psychological Therapies	168	Fair	Morone NE	2009	4	Morone NE, Rollman BL, Moore CG, et al. A mind-body program for older adults with chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2009;34(10):1053-61.
STUD167	26903081	https://www.ncbi.nlm.nih.gov/pubmed/26903081	A Mind-Body Program for Older Adults with Mindfulness-Based Stress Reduction	Psychological Therapies	167	Fair	Morone NE	2016	4.5	Morone NE, Greco CM, Moore CG, et al. A mind-body program for older adults with chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2016;41(10):1053-61.
STUD166	26903081	https://www.ncbi.nlm.nih.gov/pubmed/26903081	Mindfulness Meditation and Chronic Back Pain Mindfulness-Based Stress Reduction	Psychological Therapies	166	Poor	Thirakos AE	2016	4.5	Thirakos AE, Burstein CL, Cho J, et al. Mindfulness meditation and chronic low back pain: a randomized controlled trial. <i>Spine (Phila Pa 1976)</i> . 2016;41(10):1053-61.

Figure C13. Setting up the outcomes sheet in the workbook

OutcomeID	Condition	StudyID	Term	EffectOn	Scale	Total N	FollowUp (months)	Control N	Control Mean	Control SD	Inter N	Inter Mean	Inter SD	SMD	Confint_Low	Confint_High	Summary_I_Squared	Summary_p	Number_of_Studies
1	OUT001	CON001	STUD002	Short	Function	RDQ(0-24)	154	4	77	12.2	6.7	77	10.3	7	-0.28	-0.59	0.04		
2	OUT002	CON001	STUD009	Short	Function	ODI(0-100)	124	6	40	28.1	17.3	84	31	17.1	0.17	-0.21	0.55		
3	OUT003	CON001	STUD030	Short	Function	PDI(0-70)	54	3	24	12.6	10.2	30	5.7	6.6	-0.81	-1.37	-0.25		
4	OUT004	CON001	STUD032	Short	Function	RDQ(0-24)	86	4.5	43	6.7	5.6	43	4.5	4.5	-0.58	-0.86	0		
6	OUT005	CON001	STUD031	Short	Function	RDQ(0-24)	75	4	38	10.6	5.4	37	10	5.1	-0.11	-0.57	0.84		
7	OUT006	CON001	STUD033	Short	Function	RDQ(0-24)	60	3	30	10.7	6.2	30	7	5.4	-0.63	-1.15	-0.11		
8	OUT007	CON001	SUMMARY	Short	Function	minimal interven	553											56.9	0.041
9	OUT008	CON001	STUD028	Intermediate	Function	RDQ(0-24)	154	10	77	12.3	6.4	77	11.4	7.8	-0.13	-0.44	0.19		
10	OUT009	CON001	STUD029	Intermediate	Function	ODI(0-100)	124	10	40	23.9	17.8	84	25.8	17.8	0.11	-0.27	0.48		
11	OUT010	CON001	STUD030	Intermediate	Function	PDI(0-70)	54	9	24	11.4	11.4	30	5.7	8.1	-0.58	-1.13	-0.03		
12	OUT011	CON001	SUMMARY	Intermediate	Function		332											51	0.13
13	OUT012	CON001	STUD029	Long	Function	ODI(0-100)	124	24	40	27	17.8	84	27	21	0	-0.38	0.38		
14	OUT013	CON001	SUMMARY	Long	Function		124												
15	OUT014	CON001	STUD028	Short	Pain	VAS(0-10)	154	4	77	5.6	2.5	77	5	2.9	-0.6	-1.46	0.26		
16	OUT015	CON001	STUD029	Short	Pain	VAS(0-10)	124	6	40	3.4	3.6	84	2.9	2.8	-0.56	-1.85	0.73		
17	OUT016	CON001	STUD030	Short	Pain	VAS(0-10)	54	3	24	4.3	2	30	2.7	2.8	-1.08	-3	-0.36		
18	OUT017	CON001	STUD032	Short	Pain	VAS(0-10)	86	4.5	43	5.3	2.3	43	4.5	2.2	-0.8	-1.77	0.17		
19	OUT018	CON001	STUD031	Short	Pain	VAS(0-10)	75	4	38	3.5	2.5	37	3.2	2.3	-0.3	-1.41	0.81		
20	OUT019	CON001	STUD033	Short	Pain	VAS(0-10)	60	3	30	5.8	2.9	30	4.2	2.8	-1.6	-3.07	-0.13		
21	OUT020	CON001	SUMMARY	Short	Pain	minimal interven	553											0	0.554
22	OUT021	CON001	STUD028	Intermediate	Pain	VAS(0-10)	154	10	77	6.3	2.3	77	5	2.9	1.3	-2.13	-0.47		
23	OUT022	CON001	STUD029	Intermediate	Pain	VAS(0-10)	124	10	40	3	3.2	84	2.3	2.7	-0.71	-1.86	0.45		
24	OUT023	CON001	STUD030	Intermediate	Pain	VAS(0-10)	54	9	24	4.5	2.2	30	2.4	1.8	-2.12	-3.24	-1		
25	OUT024	CON001	SUMMARY	Intermediate	Pain		332											33.6	0.222
26	OUT025	CON001	STUD029	Long	Pain	VAS(0-10)	124	24	40	5.1	3.4	84	3.5	2.9	-1.55	-2.78	-0.32		
27	OUT026	CON001	SUMMARY	Long	Pain		124												
28	OUT027	CON001	STUD033	Short	Function	ODI(0-100)	99	4.5	45	32.9	17.6	54	31.3	21.1	-0.08	-0.48	0.31	N/A	
29	OUT028	CON001	STUD092	Short	Function	RDQ(0-24)	701	4.5	233	8	4.7	468	6.5	5	-0.31	-0.46	-0.15		
30	OUT029	CON001	STUD089	Short	Function	MRDQ(0-23)	228	4.5	112	7.9	4.8	116	7.1	5	-0.17	-0.43	0.09		
31	OUT030	CON001	SUMMARY	Short	Function		1028											0	0.456
32	OUT031	CON001	STUD095	Intermediate	Function	RDQ(0-24)	234	6	118	8	5.4	116	6.5	4.7	-0.3	-0.55	-0.04		
33	OUT032	CON001	STUD092	Intermediate	Function	RDQ(0-24)	701	10.5	233	7.9	4.7	468	6.6	5	-0.26	-0.42	0.11		
34	OUT033	CON001	STUD089	Intermediate	Function	MRDQ(0-23)	228	10	112	7.5	4.8	116	6.7	5	-0.15	-0.41	-0.13		
35	OUT034	CON001	SUMMARY	Intermediate	Function		1163											0	0.708
36	OUT035	CON001	STUD090	Long	Function	RDQ(0-24)	234	12	118	8	5.5	116	6.7	5.6	-0.23	-0.49	0.02		
37	OUT036	CON001	STUD092	Long	Function	RDQ(0-24)	701	34	233	7.4	4.7	468	6.1	5	-0.26	-0.42	-0.11		
38	OUT037	CON001	STUD089	Long	Function	MRDQ(0-23)	228	22	112	7.2	4.7	116	6.7	5	-0.34	-0.6	-0.08		
39	OUT038	CON001	SUMMARY	Long	Function		1163											0	0.830

Figure C14. Setting up the Summary sheet in Tableau

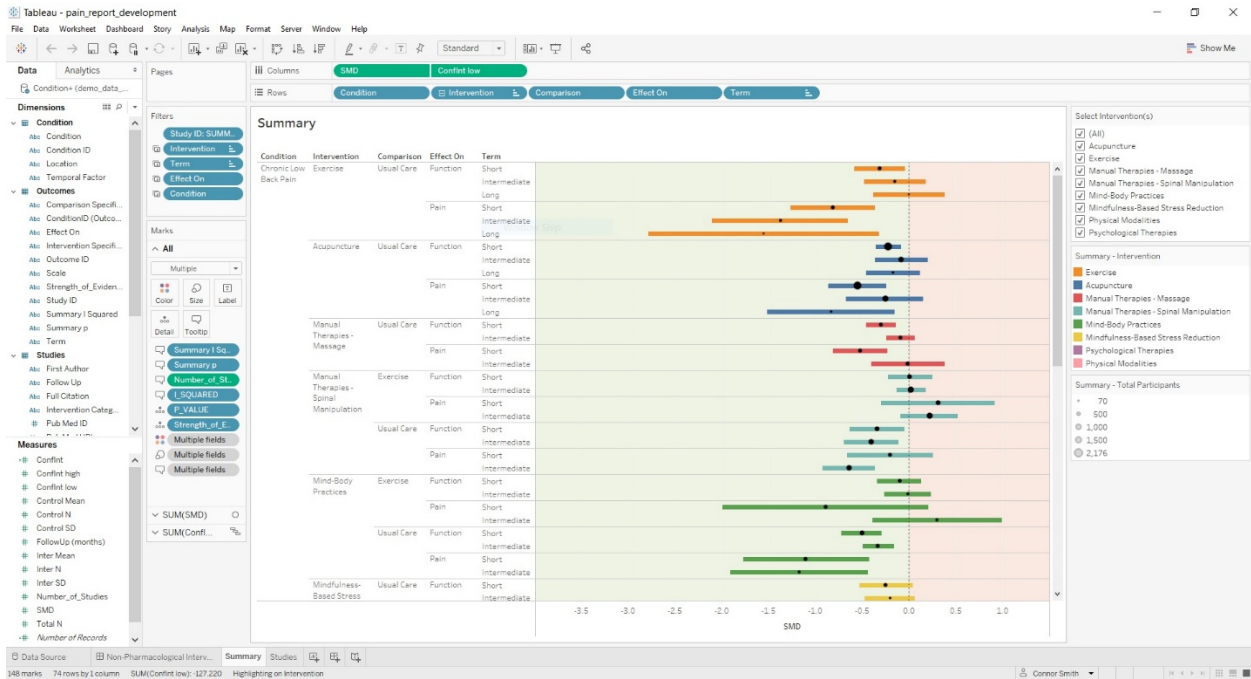


Figure C15. Setting up the Studies sheet in Tableau

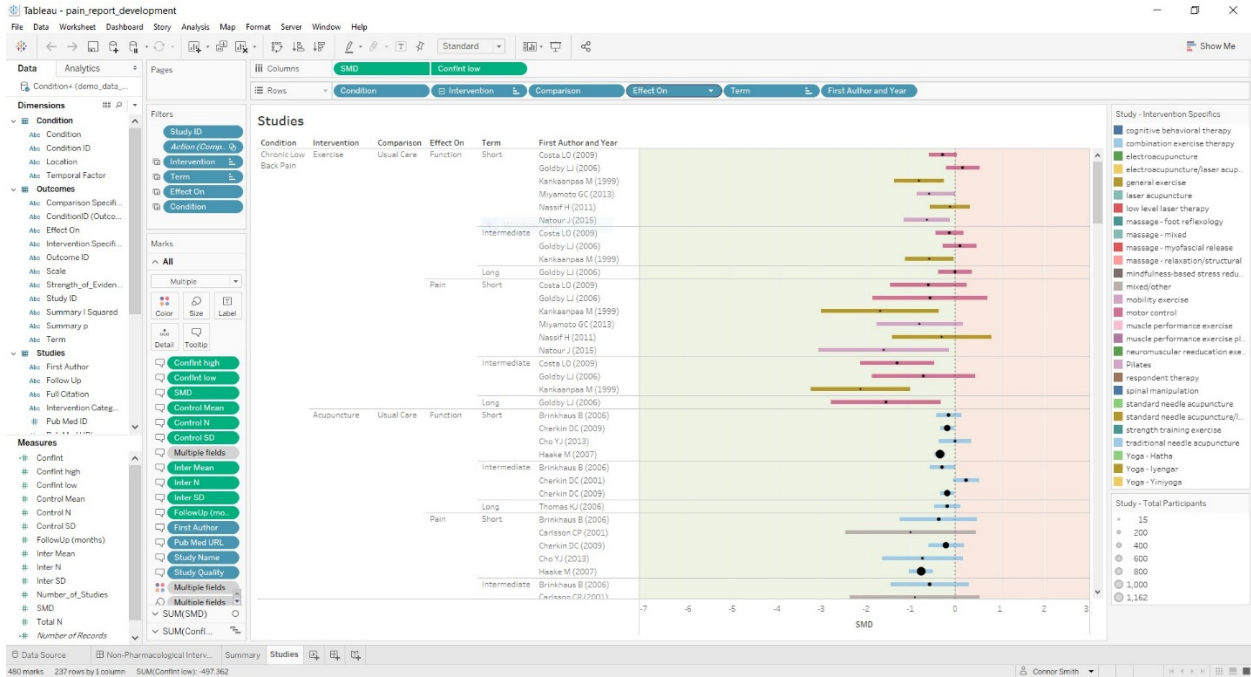


Figure C16. Setting up the Dashboard in Tableau

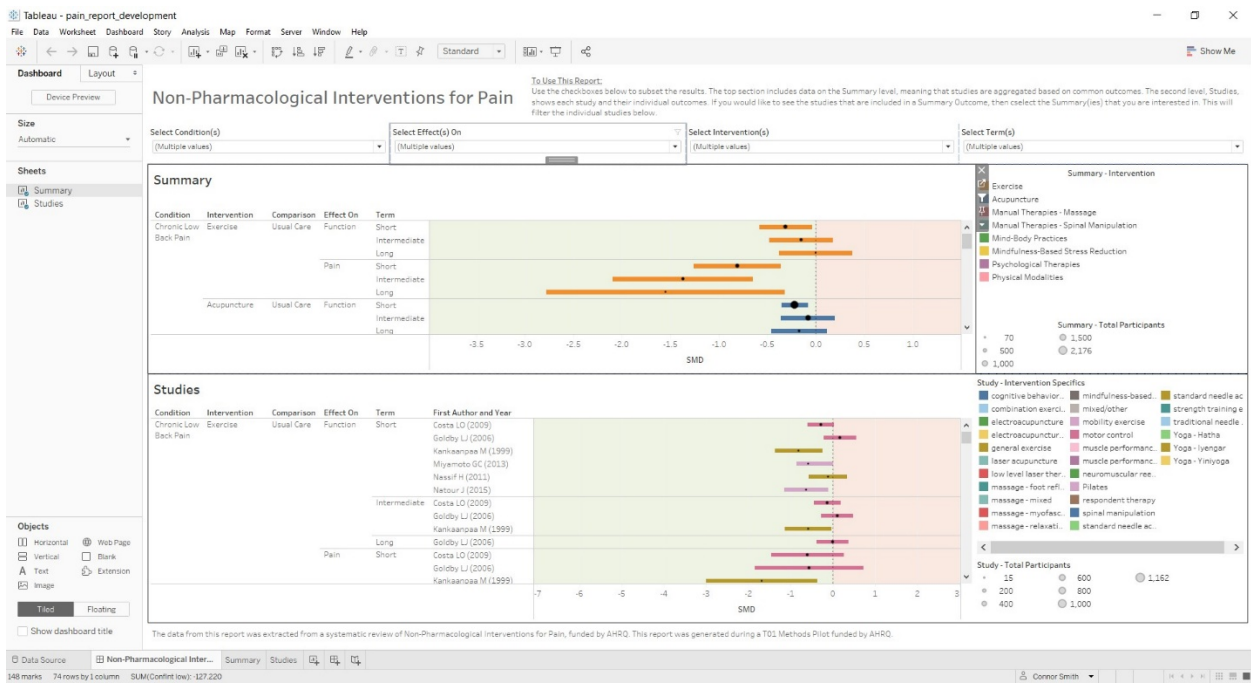


Figure C17. Extra details pop-up on Summary sheet in Tableau

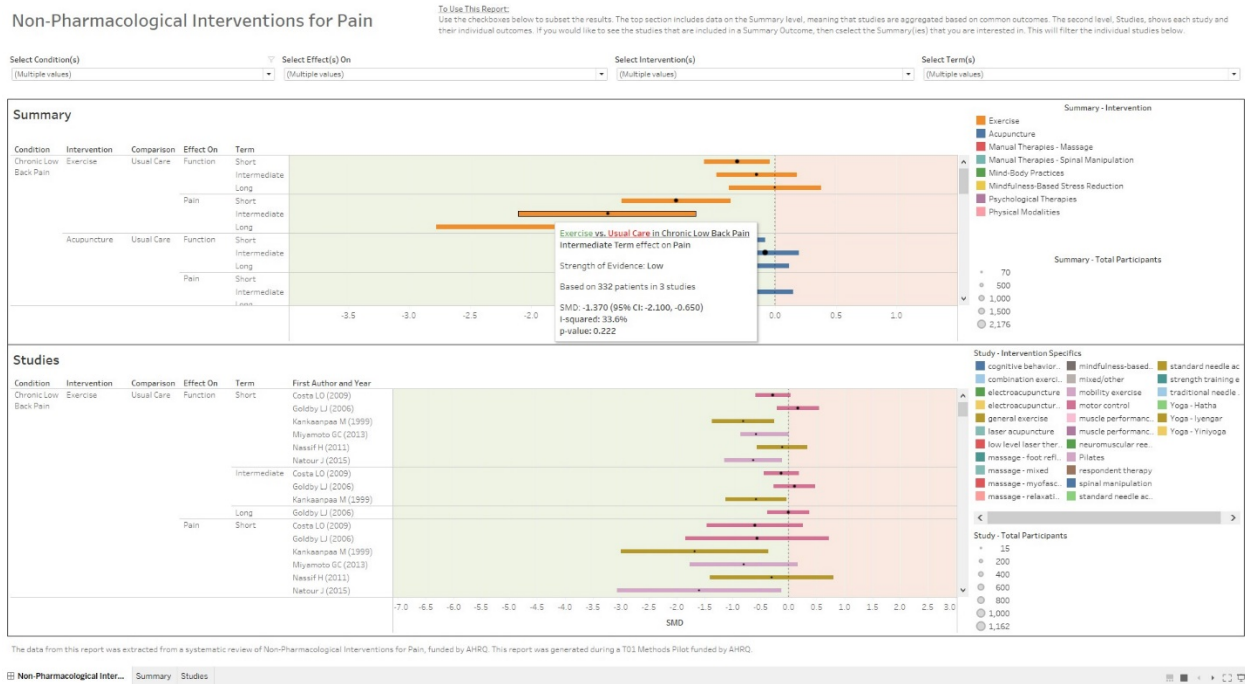


Figure C18. Extra details pop-up on Studies sheet in Tableau

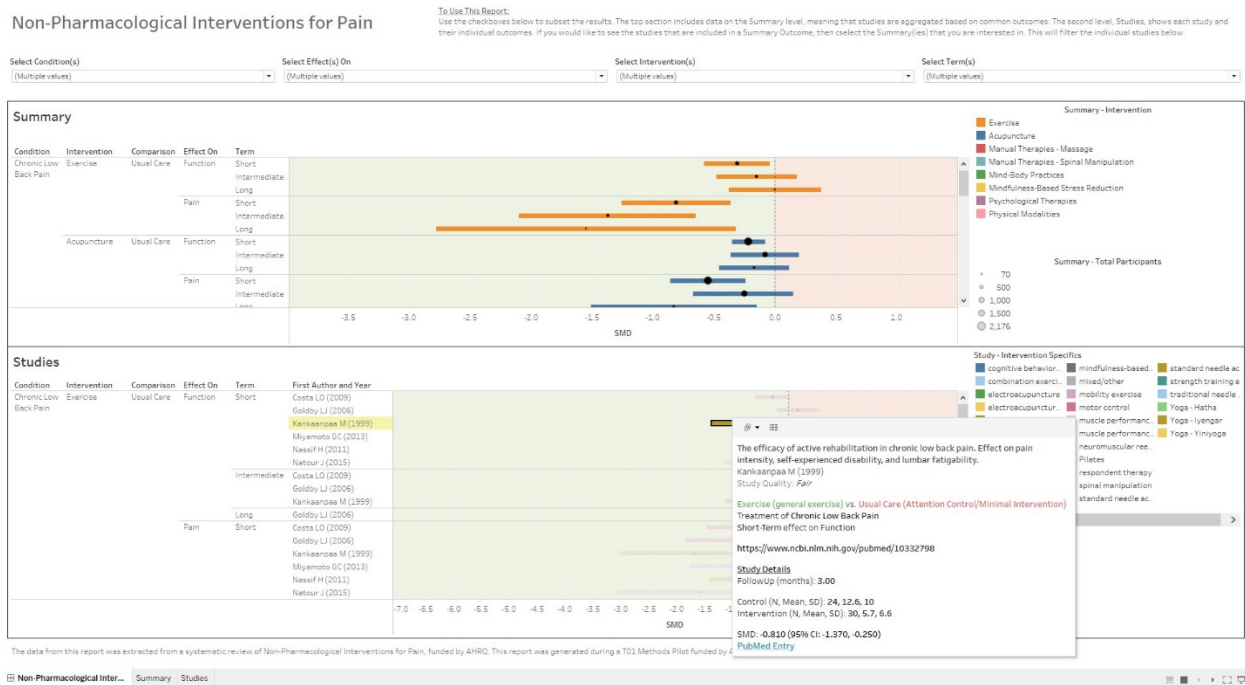


Figure C19. Filtering the Studies based on selection in the Summary section on Dashboard in Tableau

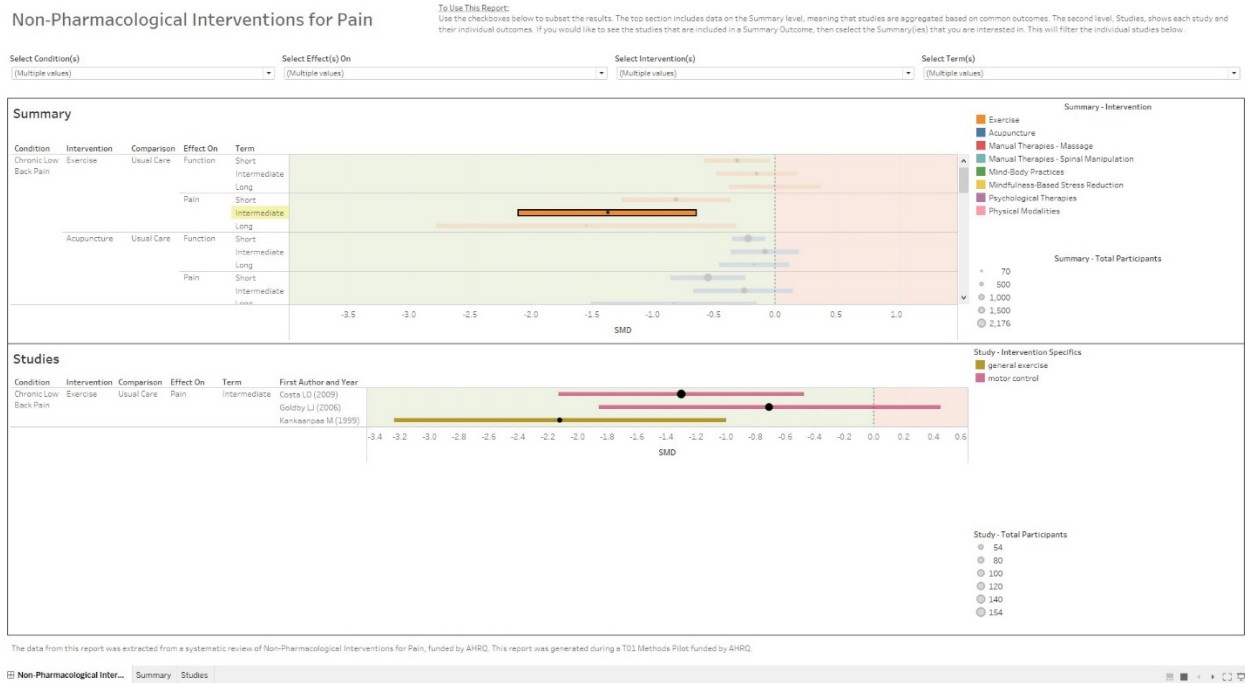
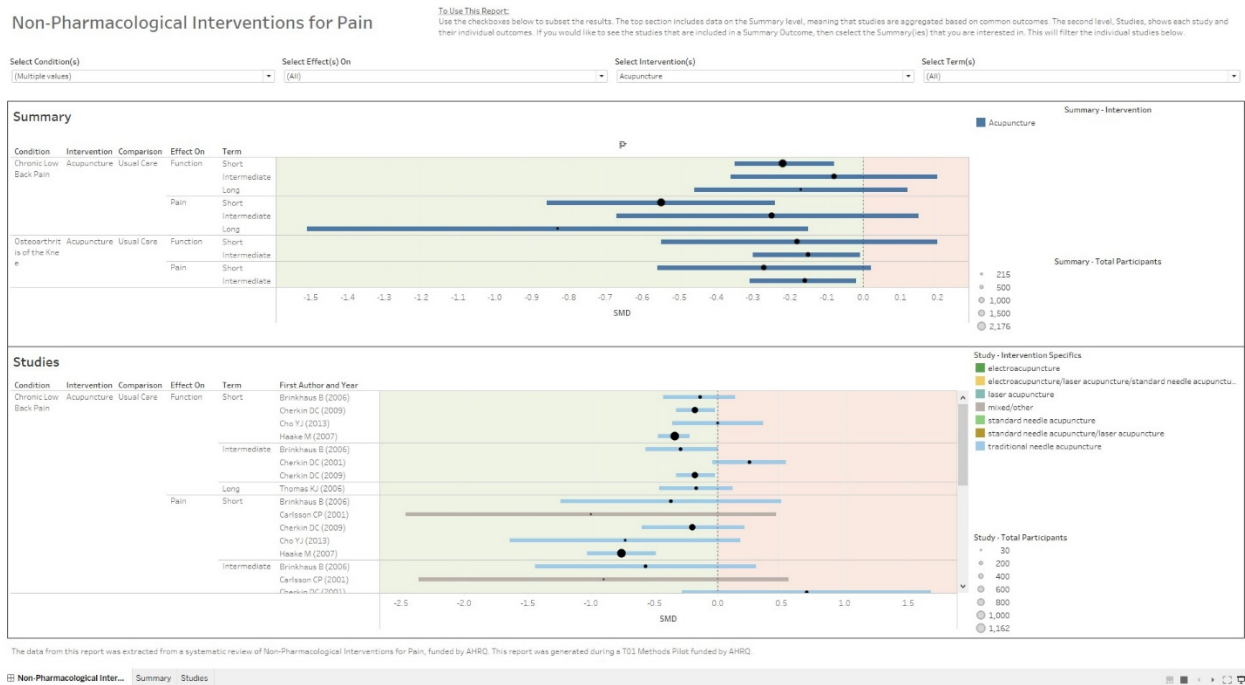


Figure C20. Filtering the Dashboard based on selections in the filter in Tableau



Screenshots of final product testing

Figure C21. MAGICapp evidence summary

URL: <https://app.magicapp.org/app#/evidence-summary/150>

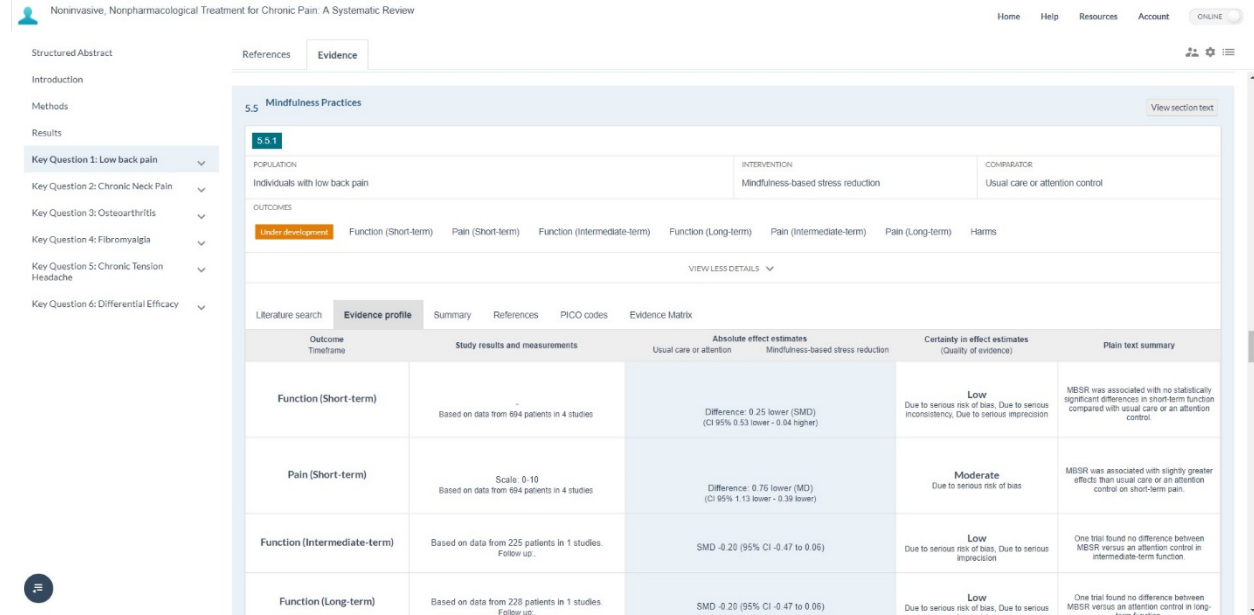
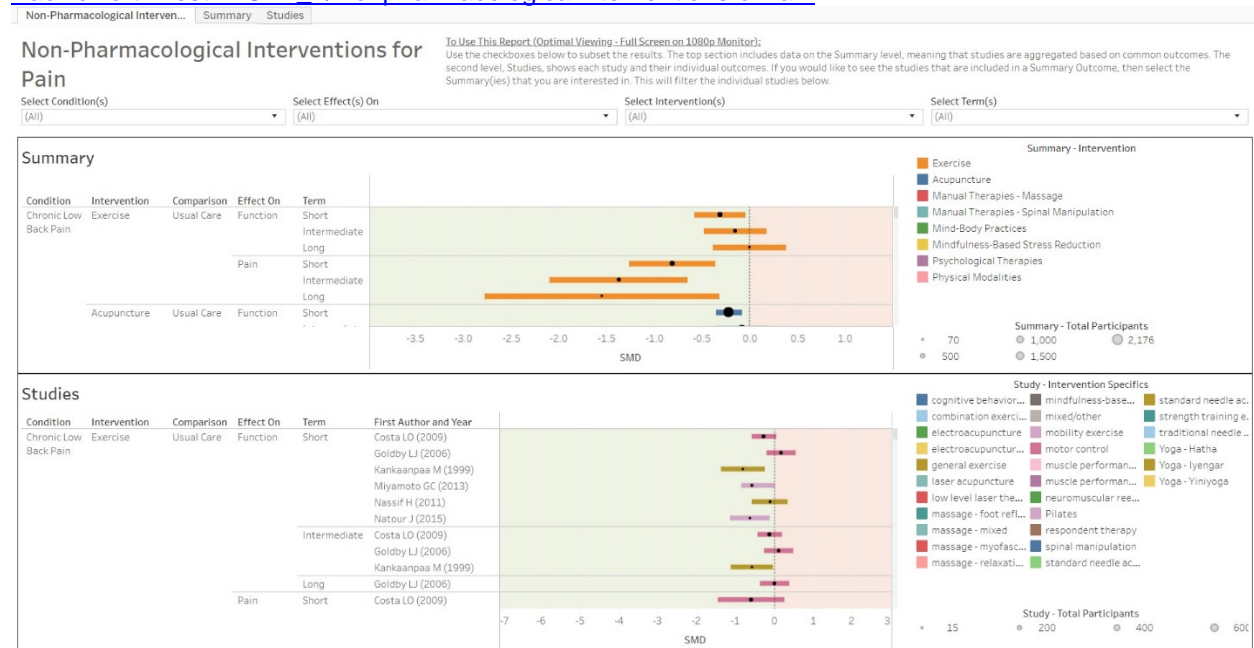


Figure C22. Tableau® dashboard

URL: https://public.tableau.com/profile/connor.jp.smith#!/vizhome/AHRQT01MethodsPilot-PacificNorthwestEPCV2_1/NonpharmacologicalInterventionsforPain



The data from this report was extracted from a systematic review of Non-Pharmacological Interventions for Pain, funded by AHRQ. This report was generated during a T01 Methods Pilot funded by AHRQ.

tableau