OREGON HEALTH & SCIENCE UNIVERSITY
SCHOOL OF MEDICINE – GRADUATE STUDIES

Making Systematic Reviews More Useful to Learning Health Systems: A Pilot Project

By

Kenneth Dunham

A CAPSTONE

Presented to the Department of Medical Informatics and Clinical Epidemiology and the Oregon Health & Science University School of Medicine
in partial fulfillment of
the requirements of the degree of

Master of Science Health and Clinical Informatics (HCIN) Program

September 2018

School of Medicine

Oregon Health & Science University

CERTIFICATE OF APPROVAL

This is to certify that the Master's Capstone Project of

Kenneth Dunham

"Making Systematic Reviews More Useful to Learning Health Systems:

A Pilot Project"

Has been approved

_____

Capstone Advisor

Annette M. Totten, Ph.D.

Acknowledgements

The author would like to acknowledge the input and help of Dr. Annette Totten, Ph.D., Connor Smith, B.S., Rebecca Jungbauer, Dr.P.H., M.P.H., and Elaine Graham, M.L.S. for their help and support in preparing this report and conducting the pilot project.

The author would also like to acknowledge the Pacific Northwest Evidence-based Practice Center and the staff at Oregon Health Science University for helping contribute valuable insight during the interview process.

Table of Contents

Abstract

Systematic reviews are rigorous summaries of existing clinical research that are used by a wide variety of audiences to accomplish various tasks. This form of research evidence can be very useful to Learning Health Systems as they strive to improve care processes and provide high quality care. However, there is an emerging need to make data from systematic reviews more useful and interactive. This project explored what can be accomplished with currently available information technology applications and products. The focus is on the dissemination of information from systematic reviews in a more interactive manner that would allow users to customize the information to their specific needs. Specifically, the objective was to find ways to present data electronically that would allow that users to “drill down” to the desired level of detail or “slice and dice” to get subsets of information.

In this paper we discuss how this a need was identified, how we vetted several software applications, and how we developed prototypes. We also evaluated the prototypes and make recommendations for next steps. Based on these examples of interactive information, we offer insights into the usefulness of transforming information to be more flexible for different users. With recent advances in technology, an overwhelming amount of information is available to health care professionals as well as the public. This information can help to inform decision making and positively affect the practice and delivery of care, but only if it is made more accessible.

The proper use of information, how it is displayed and disseminated, can facilitate improvements across many areas of the health care industry. Making it easier or more intuitive to interact and use research evidence provides opportunities for patients, clinicians, researchers, and healthcare organizations to reduce costs, improve quality of care and achieve improved outcomes. There are tools available today that can help users identify, select, synthesize, and summarize information quickly and efficiently to maximize its effectiveness.

Introduction

The rising cost of health care both influences and underscores the need to better develop and implement evidence-based medicine. Evidence-based medicine helps ensure healthcare professionals and organizations will be using the most cost effective and efficient treatments that save money and time for insurers, providers and patients while also improving overall outcomes. Improving the usefulness of the systematic reviews to support policy makers, providers and patients is one way to bend the rising cost of care. (1) (2)

According to the Institute of Medicine, a Learning Health System (LHS) is defined as a health system where “science, informatics, incentives, and the culture of the health care system are aligned to create a continuous learning loop.” (3) In an LHS, reliable evidence related to the outcomes, technologies and patient populations affected by treatments is necessary to facilitate learning and improvement. Information from outside sources like systematic reviews, are incorporated with knowledge generated internally by tracking patient outcomes, to be synthesized and reimplemented back into clinical processes. Incorporating real-time information into current processes helps to facilitate improved patient outcomes and improve the quality of care. (3)

Background

Agency for Healthcare Research and Quality and Evidence-Based Practice Centers

The Agency for Healthcare Research and Quality (4) was founded in December 1989 under the Department of Health and Human Services. The AHRQ helps policy makers, health care providers, and patients improve health care quality and develops and implement tools for informed decision making. The AHRQ invests in health care research to create guidelines, produce and conduct industry surveys, generate and capture meaningful data, and improve on current health care practices and areas of concern. The main purpose of the AHRQ is to ensure safe, high quality, accessible, fair, and affordable health care for Americans. Its 3 main focuses are to keep patients safe, improve quality and use data to track and maintain changes in health care. (4)

In 2003, with the Medicare Prescription Drug Improvement and Modernization Act, the AHRQ created the Effective Health Care (EHC) Program "to (1) conduct patient-centered outcomes research that investigates different drugs, devices, surgeries, and health care delivery arrangements to determine which approaches work best, for which patients, and under which circumstances and (2) communicate its findings widely to a variety of audiences." (5) As part of AHRQ responsibilities, the EHC was created to support the health care needs of Medicare, Medicaid and State Children's Health Insurance Program users.

The Pacific Northwest Evidence-Based Practice Center has operated out of Oregon Health & Science University since the original contract was awarded to the university in 1997. The OHSU EPC produces systematic reviews as well as other types of evidence reports and assessments that are often used for the development and implementation of clinical guidelines, pathways and other quality improvement tools and methods. (6) The Pacific Northwest EPC is one of 13 EPC's and supports the AHRQ in its effort to "promote the synthesis and translation of evidence",

"improve validity and utility of systematic reviews for decision making", and "improve the consistency and cohesiveness of the EPC program." One of their underlying focuses is the future state of health care and work at the OHSU EPC focuses on identifying future needs. (6)

Evidence-based Practice Centers, like the Pacific Northwest EPC, review health care research and literature to produce systematic reviews. Using scientifically rigorous methods and detailed documentation, systematic reviews offer a critical appraisal of the underlying scientific knowledge about a topic or questions and are designed to be used in health care decision making and practice. EPC's develop systematic reviews to accomplish the AHRQ goal of evidence-based medicine and as a trusted source of knowledge and expertise for policy makers, providers and patients. The Pacific Northwest EPC partners with various agencies to meet the health care needs of the community and participates in many different programs involving both local and national partnerships. (6)

Learning Health Systems and Evidence-based Medicine

Evidence-based medicine and Learning Health Systems are important areas in health care that rely on the EPC and systematic reviews. In order to be useful, systematic reviews must be relevant and timely, objective and scientifically rigorous, and allow for public participation and transparency. (2) Systematic reviews cover a range of topics such as, “drugs and devices, diagnostic tests, and healthcare system interventions.” (2) Information and systematic reviews have evolved as a means to meet the needs of healthcare professionals who need evidence for clinical policies and guidelines. (2)

Evidence-based care requires the ability to synthesize large bodies of information or the availability of existing syntheses that match a particular problem. If a problem is unique, it can be difficult to get information if current systematic reviews are limited in scope or there is only a few disparate sources of similar information. Sometimes finding information that is useable and relative can be difficult.

Alternatively, when there is a lot of information about a particular topic or problem, systematic reviews can become onerous documents consisting of hundreds of pages of texts, images, tables, charts, and graphs. Some systematic reviews require immense time to read and search through. Some users may find systematic reviews relate to a problem or interest, only to discover the review is either so specific or so overwhelming it is disqualified from any useable applications.

Systematic reviews may also have useful information within them but that information could be particularly hard to find or in a format that is unusable for a particular audience. In their current state, electronic copies of systematic reviews (usually pdfs of reports or journal articles) may sometimes be only marginally better than a physically printed copy. Transforming the traditional systematic review from a mostly static, one dimensional piece of digital literature into an interactive and multidimensional format, may be one way to improve their usefulness.

Rationale

The AHRQ had asked all the EPCs to propose pilot projects designed to make the EHC program's products more useful to Learning Health Systems. Pursuing the improvement of

systematic reviews supports the AHRQ's program of methods projects and facilitates the advancement of science and technology to improve evidence-based medicine. We chose to focus on issues with the format and presentation of systematic reviews, not their content.

Although available in electronic formats like word documents and spreadsheets, systematic reviews are often inflexible, and their contents may not adhere to any obvious file formats or data. It is important to understand that the format of information affects how it can be used and what programs or applications can use it. For instance, what may look like a spreadsheet in a report may actually be an image of a spreadsheet. The difference being, the information in the cells of a spreadsheet may not be useable beyond reading if the spreadsheet itself is stored as an image.

With the AHRQ's support and investments in developing health systems, improving systematic reviews can help to achieve the quadruple aim of 1) enhanced patient experience, 2) improved population health, 3) reduced costs of care, and 4) health care professionals satisfied and joyous in their work (7) . Evidence-based medicine operationalized through clinical protocols can contribute to better health, better quality care, improved access and lower costs. (2) One of the ways to realize this is by taking advantage of new applications and technology that could make systematic reviews more dynamic and flexible. Making sure the EHCs products are more suited to meet the technological demands of today's users means these products will be more useful in real world settings.

Objective

The objective of this pilot project was to develop and test ways to present the results of a large, complex systematic review that would make them more useful to Learning Health Systems. The development of these solutions was based on a collaborative effort with the local health system, Oregon Health and Science University. Our goal was to understand the local health system's needs, evaluate existing tools that met those needs and then provide recommendations and next steps to improve the usability of systematic reviews.

To complete our project, we worked alongside Elizabeth Crabtree, PhD, MPH, the OHSU Director of Clinical Integration and Evidence-based Practice, OHSU Healthcare. Dr. Crabtree provided her expertise in the areas of strategic planning, execution, and implementation of evidence-based clinical practice.

The Pacific Northwest Evidence-based Practice Center at OHSU conducts systematic reviews on healthcare topics for federal, state and other agencies. Their work is integral for clinicians, policy makers and researches making related to health care and health care services. The work accomplished by Pacific Northwest EPC is sponsored by the Agency for Healthcare Research and Quality. The Pacific Northwest EPC is located in the OHSU School of Medicine, Department of Medical Informatics and Clinical Epidemiology, and is partnered with the University of Washington CHASE Alliance in Seattle, and Spectrum Research, Inc., in Tacoma, Washington

Methods

To conduct our project, we used a four-phased approach consisting of: Phase 1) A pre-development assessment which included an examination of AHRQ reports and literature as well as interviews with local guideline developers and systematic review users, Phase 2) defining criteria for prototypes which involved outlining the functionality we wanted and defining the requirements for the tool, Phase 3) the development of a working prototype, and Phase 4) the evaluation of prototypes to stakeholders and local users. Feedback will be shared and incorporated into recommendations and next steps.

PHASE 1: Pre-development assessment

A literature review was conducted to gain an understanding of how systematic reviews are viewed and used by health care professionals. We searched PubMed for literature published between 2002 and 2017 using terms related to usability including, "information dissemination", "evidence synthesis", and "systematic review usability". We reviewed over 30 titles and abstracts before downloading the most useful results. The final articles we reviewed covered the dissemination and synthesis of evidence for decisionmakers and tools encouraging evidence in decision-making. (8-22)

In addition to literature about dissemination of systematic reviews, the team was interested in searching for software or applications that make data interactive and present information in layers. Reviews that focused on organizing large sets of information were also a priority since systematic reviews could contain hundreds of pages of information. Saving time while navigating a large report and finding information quickly was an important factor. An additional emphasis was placed on being able to skip or jump between chapters, sections or headings of reviews.

Feedback from guideline developers

To better understand how research was used in the guideline development process, we conducted 15-minute interviews. We contacted six clinicians involved in local guideline development and completed interviews with four. We asked them the following questions to gain insight into how research was used in the guideline development process.

Below are the interview questions:

1. What is your current title/role?
2. Overall, describe your experience developing the OHSU guideline "X"?
    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.
       If no, thank you for your time and participation.

A detailed synthesis of their responses is presented in "Results."

Phase 2: Defining criteria for prototypes

The team evaluated the reports from the literature review to understand what would make systematic reviews more useful and interviews were conducted during the development process to solicit feedback from guideline users and developers. The team looked for software whose main focus was the dissemination of information. The team was attracted to applications that had the ability to "slice and dice" and "drill down" into data. We were focused on the ability to interact with data in order to find information easily. The idea of presenting information in "layers" or in multiple levels was also appealing to us because we wanted to easily present information at a high level as well as granularly.

The team wanted to focus on tools that were intuitive with a learning curve that is not too steep. It was important that the tool be learnable and not technically daunting to use. Interviews and presentations were conducted during the development process and used to solicit feedback from guideline users and developers. Based on the needs outlined by the AHRQ and in, we felt a possible solution to the problem from an informatics perspective were already in existence. It was also important that the tool be available off the shelf with technical support available for foreseeable future. The tool had to be publicly available, just as an AHRQ report would.

Phase 3: Prototype Development

To begin our project we selected the *Noninvasive, Nonpharmacological Treatment for Chronic Pain Protocol* report produced by the Pacific Northwest EPC. The main body of the report is more than 300 pages long and contains data in more than 62 tables, 52 figures, and 1066 pages listed in the appendix of the report. The most critical aspect of using a report from the OHSU was access. Using a report from our EPC allowed us direct access to the data within the report and gave us the opportunity to collaborate with the report authors.

The team felt the AHRQ report contained enough data to create a functioning prototype that could display information from the report in an interactive manner. We contacted several organizations and application developers whose products we were interested in using. In the end, we chose to use MAGICapp (http://magicproject.org/) and Tableau (http://tableau.com) and produced 2 prototypes – one for each application. Throughout the project lifetime we had several meetings with MAGICapp and Tableau developers. Video conferencing allowed us to meet the development teams, explain our project and goals, (MAGICapp is based in Norway and Tableau is from San Francisco), ask technical questions upfront, and discuss features and bugs we needed to clarify. Both teams of developers were extremely helpful and accommodating with our project.

Phase 4: Evaluation of Prototypes

After our prototypes were developed we wanted to present our findings to the original interviewees and get additional feedback. The team wanted to circle back to our original interviewees to show them what was done with their input. We wanted to compare and highlight the enhancements we made to support dynamic visualizations, data interactivity, and information layering.

We also presented our project at the AHRQ EPC-V Annual In-person Meeting held on June 4th and June 5th, 2018 in Baltimore, Maryland and to the EPC staff at OHSU. Lastly, we presented to the Office of Clinical Integration and Evidence-Based Practice at OHSU. We presented to the additional audiences to gain exposure and buy-in from current users of systematic reviews and all presentations with the exception of the AHRQ EPV-V meeting were 30-60 minutes in length.

Below are the follow-up questions and topics of discussion for the original interviewees:

1. What did they like about the Tableau/MagicApp Presentation?
2. What is missing that they would like to have?
3. Which one feature is most important and should be kept?
    a. Who do you think would use either of these?
    b. How or When would them use them?

Results

Phase 1: Pre-development Assessment

Summary of Literature Review

Because systematic reviews inherently contain large quantities of information they can be difficult to synthesize or use efficiently. We conducted a review of the literature related to the dissemination of systematic reviews. While there was much information regarding the implementation of clinical information, little work has been done regarding the presentation and use of systematic review data in a visual manner. Searches for information regarding the interactive possibilities for systematic reviews did not identify published studies.

A systematic review conducted by Perrier et al found after reviewing abstracts and titles of over 8,000 studies, only five addressed issues surrounding the application of evidence from systematic reviews for decision making. (23). Perrier et al found that major themes surrounding the presentation of information from systematic reviews involved “ease of use, clarity, brevity, and implementation.” (24) Shortened summaries of key points from systematic reviews were favored. It was important that summarized information match the quality of the full-length reports. (25)

Systematic Reviews are useful because they contain immense amounts of knowledge and information that can help patients, practitioners and payers improve outcomes. But through our literature review, we found that review size and density could be a barrier to effective use. Petkovic et al found that systematic reviews often have little impact on usefulness, usability or decision-making. (26) (1)

When systematic reviews are too large and too densely packed with information they are difficult to use effectively. A contributing factor is that SRs may use many disparate types of studies and may be designed to compare a broad range of therapies, approaches, or setting even if they focus on a single, clinical problem. Many reviews include data about differences between studies and compare interventions that have diverse populations, with varying levels of bias, and with varying methods of treatments and varying outcomes. Since size is a consequence of their intended function, reviews will continue to be large as the advances in treatment and data collection continue. (2)

The team of Tricco et al looked at some of the barriers affecting the use of systematic reviews and found that simple things like a one-page summary, highlighting key points and knowing how to speak to your audience could make big improvements in usability. (27) Their analysis also highlighted the need to have systematic reviews that are produced by trusted organizations or programs. Strong relationships can help facilitate trust in the validity of the content of reviews. (27)

Other studies reported similar results regarding systematic review length as a barrier to usability and implementation. Rosenbaum et al found that creating short summaries were useful in making reviews easier to use. The authors also mentioned that summaries must be clear and easily scannable. (17) They highlighted a critical point of reviews needing to explain the context of the information being provided. Being able to contextualize the data presented in systematic reviews is what gives the data meaning and makes it information. Providing context for the data to help inform decision-making should not be overlooked.

Most of the other relevant papers we reviewed were about the barriers of using systematic reviews for decision-making in clinical settings and included topics such as the lack of trust in research or ma lack of timeliness or relevance. A lack of access to research and reviews was another cited barrier to effectively using systematic reviews. Trust is an important factor in the usability of SRs and Healthcare professionals cannot use a systematic review if they cannot find trusted information or have no practical way to obtain it. Systematic reviews also faced the barrier of relatability. To be useful, SR's have to be relatable and applicable to the practical settings they will be used in. (20, 22, 28, 29)

Summary of AHRQ White Papers

The AHRQ White Paper shared similar recommendations and findings with the other reviewed literature. Having concise information that was succinct and available quickly was identified as a major factor of usability in a health system. Additionally, layering of information or allowing users to go from a general high-level of detail down to a more granular level was highlighted as a desired feature of information dissemination. The paper also found that information was more usable when presented in the local context of health system's needs and that information is less useful when not applicable to the context of the scenario. (30)

Another important factor regarding usability of evidence for decision making is how evidence intersects with other considerations to affect the decision-making process. Clinicians act within the context of their environment and have to consider how the evidence may or may not support the question they are trying to answer. The trustworthiness of information was also noted.

Information is less likely to be used if the generated reviews and summaries are not trustworthy or if the evidence itself is not trustworthy. (30)

Summary of pre-development interviews

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. 3 of 4 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. 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.

3 out of 4 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 their 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 that “there was a lot of evidence”. The reviewer recommended a prescreening of evidence limit or narrow focus.

When asked about what could done to change the format and presentation of evidence for future guideline development meetings, 1 of the 4 interviewees were satisfied with the way information was presented and recommended no changes. The other 2 interviewees recommended changes to the way the information was presented. One interviewee wanted, “different way to visualize the information, color coding for good studies” and studies to be

limited to, “studies with relevance”. Additionally, one interviewee encouraged 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 AHRQ EPC reports, one reported they “sounded familiar” and two stated they were not familiar with AHRQ EPC reports.

Phase 2: Defining criteria for prototypes

Our main focus was on finding tools/products already available, with sufficient back-end or technical support. The software needed to be available now and should have a robust platform or ecosystem (ensuring it would more likely be usable into the future). We wanted software that did not require high levels of programming or technical expertise but still allowed for the presentation of information in layers or various interactive ways.

Two tools that we considered but did not use were VIZSweet and STATSilk.VizSweet was considered for its flexibility in its visual presentation of data. VizSweet was adaptable to display many different kinds of data in many different ways. The graphical representation of data was interactive - users could manipulate charts, graphs and visualizations, information could be pivoted or seen from multiple angles, and information was also displayed in several different layers (i.e. by size, color, position on graph and etc.). VizSweet is also popular, with their team appearing on TED talks as well as recently publishing a book about infographics. VizSweet has a strong development team and is currently working to offer their product for commercial use. However, the product is not yet available for beta testing or widespread use. After multiple attempts to contact both the company, Information is Beautiful, as well as the development team went unanswered, we had to abandon consideration of that application.

STATSilk was also chosen for its ability to display information in a variety of ways as well as across multiple platforms (i.e. mobile and web). STATSilk was similar to VizSweet in the way it offered users the ability to present information in an interactive manner with multiple layers. Customizable dashboards, interactive maps and graphs allowed audiences to manipulate information that was imported from ordinary spreadsheets. Some high-profile users of STATSilk include Dell, World Bank, and Harvard. However, despite the similarities between VizSweet and STATSilk, the option was abandoned because STATSilk runs on Flash which will be no longer be developed or supported after 2018. Although STATSilk provided a strong case for use, its lack of support beyond 2018 made it high risk for our task.

The two tools we decided to use are described below. We did not identify one tool that could easily present data in a way that would allow ‘drill down’ and ‘slice and dice’, so we decided to create prototypes with two tools.

MAGIC App was selected because it allows for the electronic presentation of both evidence summaries and guidelines and allows information to be represented electronically and in layers or levels. Additionally, MAGIC App has a robust support system and a strong core of application developers. MAGIC is aligned with the GRADE or the Grading of Recommendations Assessment, Development and Evaluation working group. GRADE started in 2000 as a group focused on developing an approach to grading the quality of evidence and strength of recommendations. (31) The GRADE methods and framework are similar to the AHRQ Method’s Guide. (2, 31) The similarity between the two and the ability to customize the MAGIC App format

and presentation structure made it an ideal candidate to test. MAGIC App is a product of MAGIC, a non-profit organization focused on enhancing the use and sharing of clinical guidelines. They work internationally with various organizations to produce and enhance guideline development.

Tableau was the second application selected. It was selected because it looked similar in capabilities to VizSweet but had more robust user tools and support. The software is designed to help its users visualize and present information that would normally be static in an interactive manner by showing the relationships among data. Tableau takes data from spreadsheets and gives the user of the visualization or dashboard, control of certain data points and variables. Tableau allows you to use "slice and dice" your data by different variables into customized subgroups. By directly interacting with the data in this manner, the user is able to see specific information based on the context of a specific question. Tableau creates insight by helping its users see relationships within their data. Tableau was also chosen for its robust support and development. Tableau is popular in the business world and its use is on the rise. Tableau is also used in health care and is familiar to many in health care systems.

Phase 3: Prototype Development

MAGIC App and Tableau were the final two software applications we chose to work with. We decided that MagicAPP would be used to recreate the AHRQ pain report from a PDF or word document into a more flexible web-based format. Tableau would be used to create a second prototype that would display the data and information from the studies within the report in a more visual format. Both software have robust technical support and development, allow for the presentation of information in layers, allow for some interactivity with data, and are available to institutions looking to use electronic information for enhanced learning and understanding.

MAGICApp Prototype Development

MAGICApp allowed the evidence summaries to be electronically translated into a more navigable and segmented form of the traditional paper report. MAGICApp was used to enhance the AHRQ pain report by making its contents more malleable – sections of the pain report can be viewed separately as denoted by the section header. If you only want to see the introduction or abstract of the paper, it can be viewed by clicking on it. Further, it is possible to expand each section of the report to see them all at once. The MAGICApp structure was easy to navigate because the GRADE framework has similarities with the framework of the AHRQ Methods Guide.

To start, we had meetings with a MAGICapp representative who gave us an overview of MAGICApp. Once we explained our goal of transforming the pain report, we were given access for the demo and had user accounts created for our project. To utilize MAGICapp, any one of our team members just had to log in to the MAGICapp portal on the MAGICapp website.

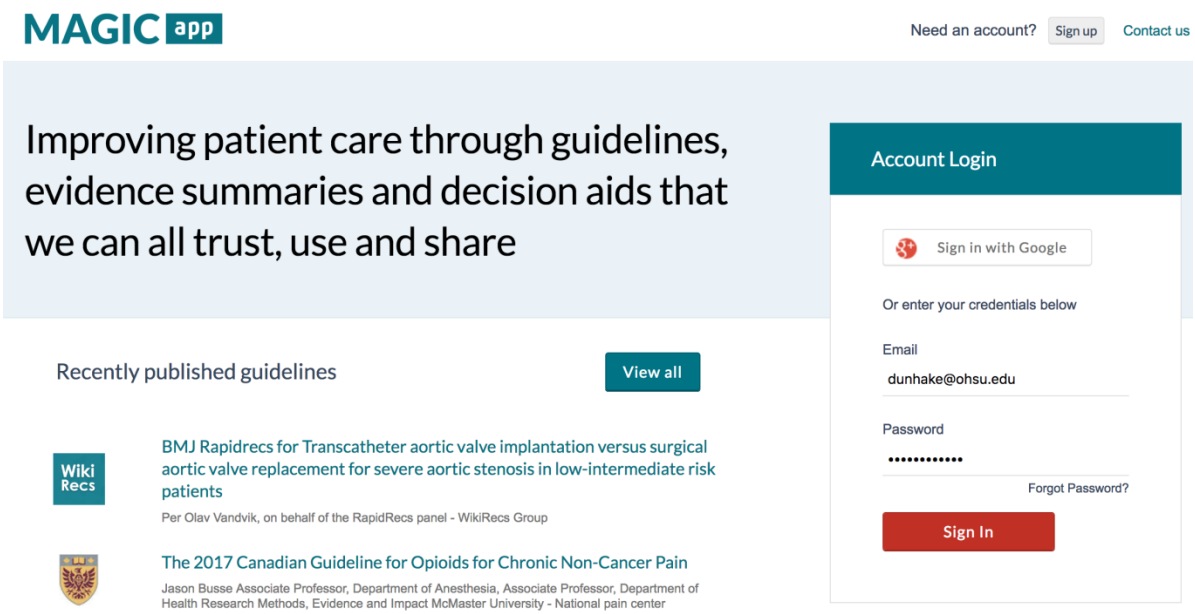


Figure 1: MAGICapp user login. https://app.magicapp.org/login

The information from the pain report was not changed or altered in any way. Following the format of the AHRQ report, the team took each section from the PDF file of the report and copied the information into the MAGICapp web tool. Getting the information directly from the report and into MAGICApp section by section allowed us to create a web-based version of each section of the report. The report was now indexed into 10 sections that included: Structured Abstract, Introduction, Methods, Results, followed by Key Question 1 through 6. For the prototype we only completed the interventions for Key Question 1. This made it possible to navigate to any part of the report quickly.

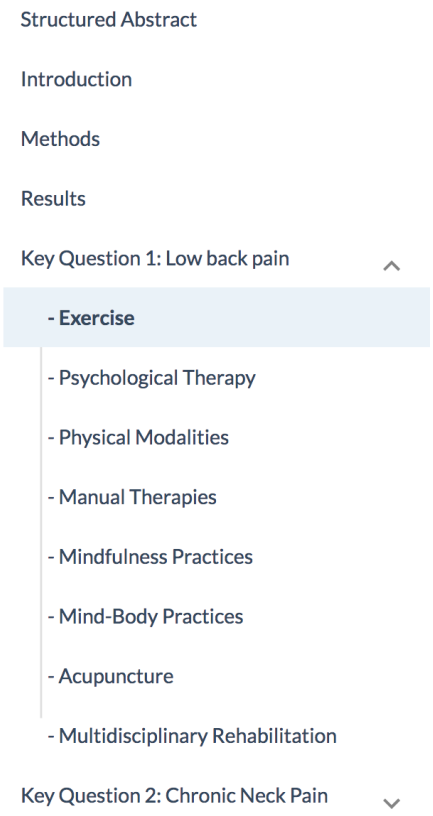


Figure 2: pain report indexed in MAGICapp

For our project we copied each section from Structured Abstract through Key Question 1: Low back pain, directly into MAGICapp. We felt this portion of the report could adequately represent the idea of layering, summarizing information, highlight key points and easing the burden of navigating through hundreds pages of text and figures.

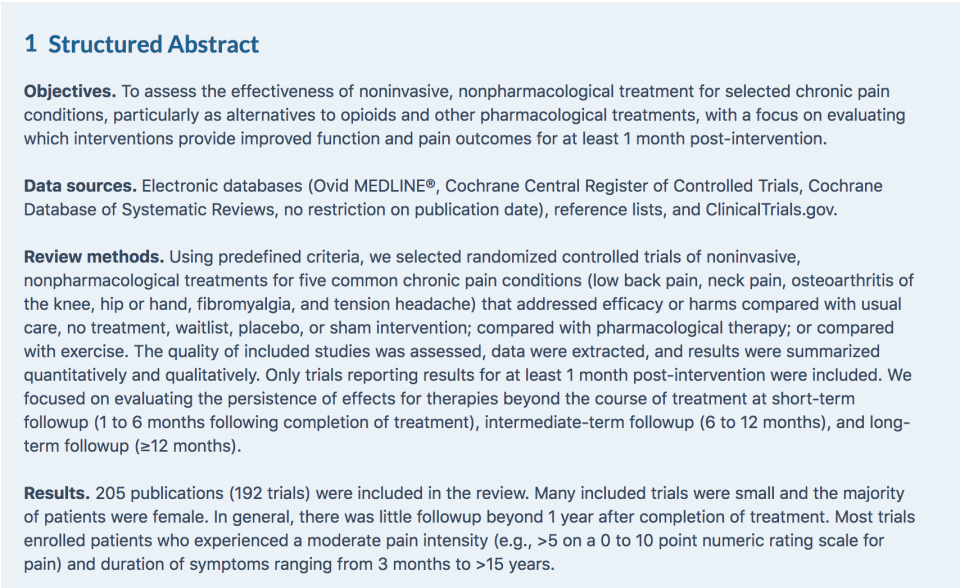


Figure 3: Sections of the report like the Structured Abstract can be viewed if selected from the index

We copied and entered all information for Key Question 1: low back pain into MAGICapp. Sticking to the AHRQ report's format we decided that each interventions and outcome group would be their own navigable sections. We took each intervention: exercise, psychological therapy, physical modalities, manual therapies, mindfulness practices, mind-body practices, acupuncture, and multidisciplinary rehabilitation and completed their evidence profiles with information from the report. The team directly copied and pasted this information, it was not recreated or edited beyond its transferring. When viewing the interventions, you can click on each outcome to see more detailed information directly from the report.

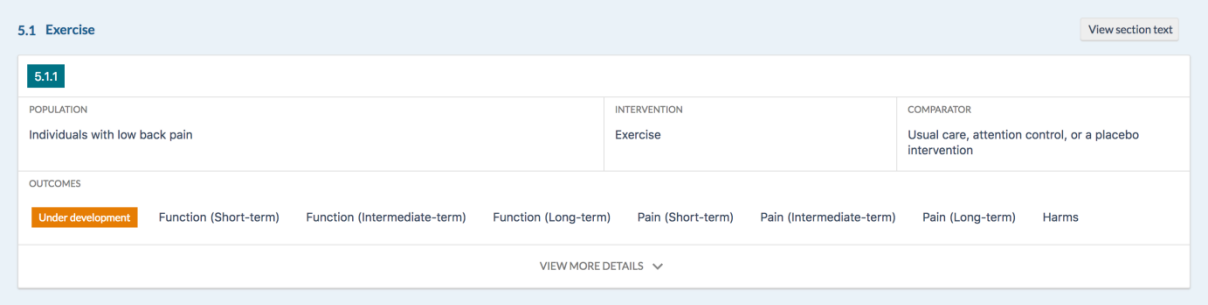


Figure 4: links to each outcome of the exercise intervention

By clicking on an outcome under a particular intervention, you will be taken to its related evidence profile. The evidence profile reflects the GRADE framework for clinical recommendations. Because of the similarities of GRADE Evidence to Decision framework and the AHRQ Methods Guidance, it was easy to translate assessments and conclusions.

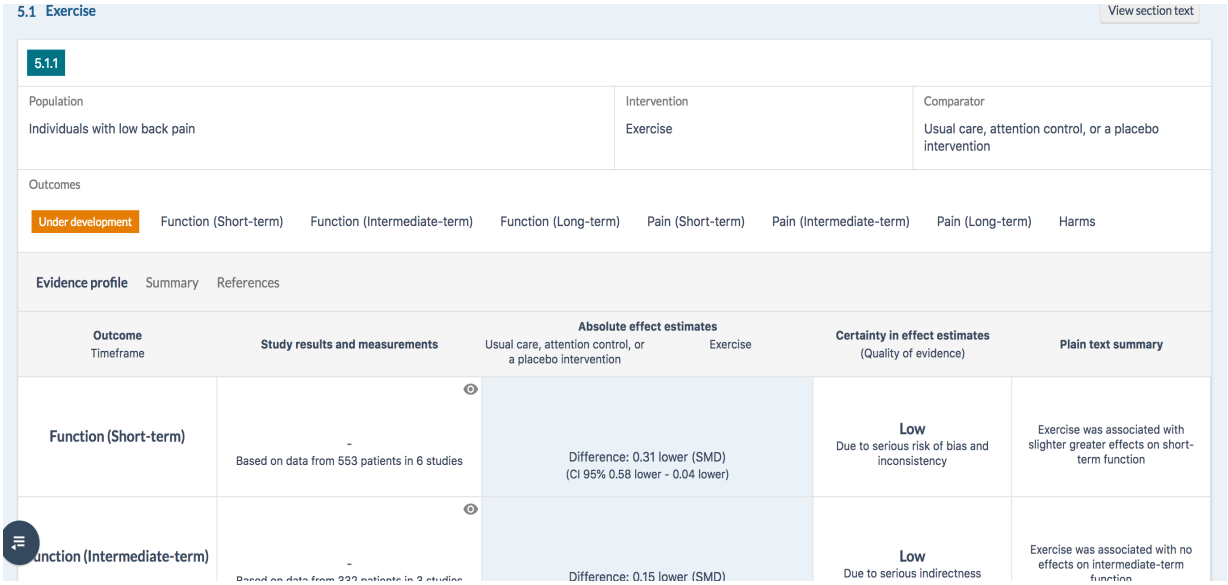


Figure 5: Summary of outcomes for studies of Exercise for Low Back Pain

Instead of flipping through hundreds of pages or scrolling continuously through a traditional report, additional information related to the interventions are on horizontal tabs in the same window. The tabs are "Evidence Profile", "Summary", and "References". These tabs contain information from the report used for the specific intervention and outcome. This information is a mouse-click away in the MAGICapp tool instead of buried within a report.

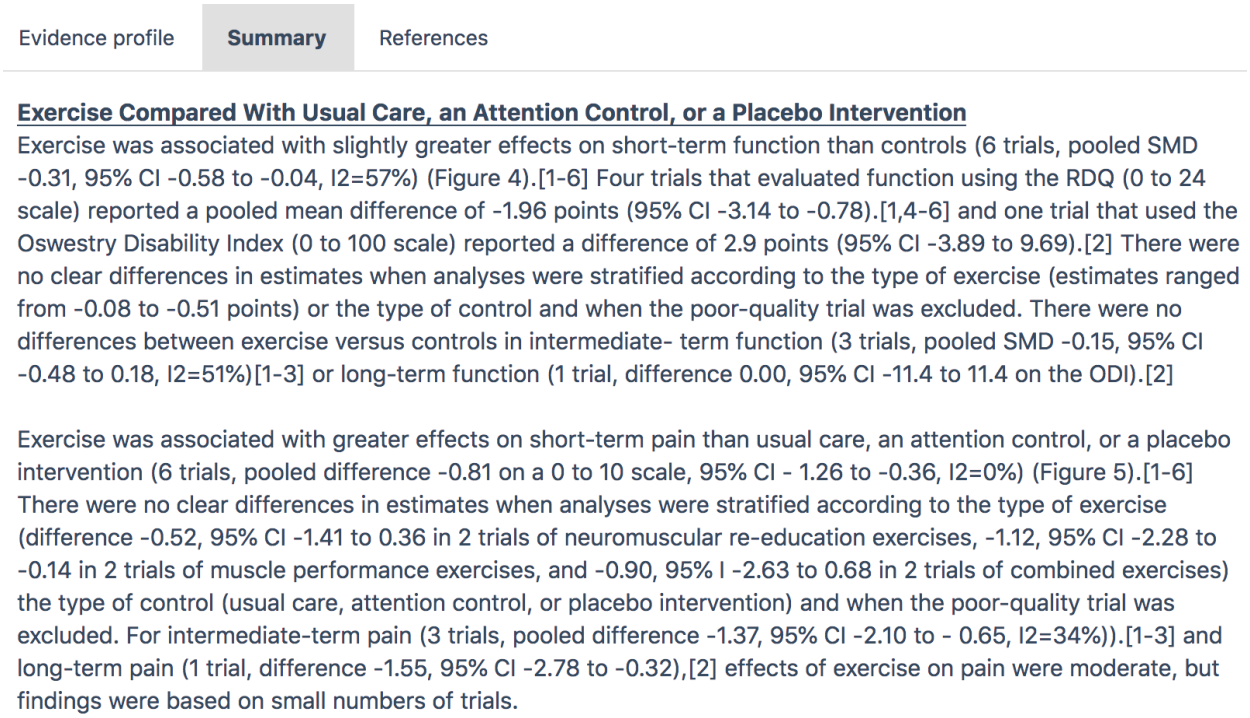


Figure 6: Summary of findings from the pain report for exercise.

The reference tab contains references specific for the section for the report the user is viewing. These references are also a mouse-click away from the evidence profile making them easy to navigate to. Additionally, references are linked to available information. The references in our report have all been linked to their respective PubMed entries. PubMed is a free search engine for references and abstracts on science and biomedical topics from MEDLINE. Linking directly to PubMed allows users to view the abstract of the related study and in some cases a free full text copy of the study. If the text is not free, users are directed to a publisher page where access beyond the abstract can be paid for. Linking our studies to their PubMed ID was completed by entering our references into the MAGICapp references tool.

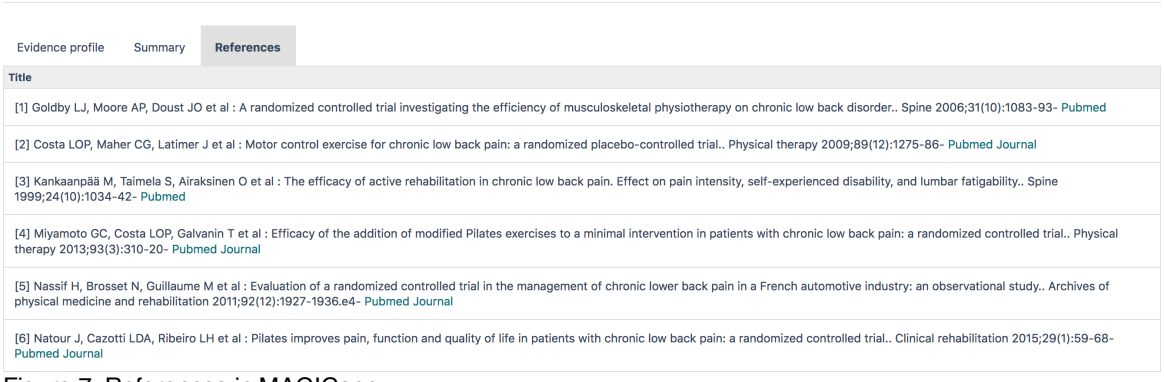


Figure 7: References in MAGICapp

It was a generally straight forward to translate information from the pain report into the structure of the MAGICapp. The most challenging aspect of transferring the information from the report was aligning the quality of evidence domains for GRADE (risk of bias, inconsistency, indirectness, imprecision and

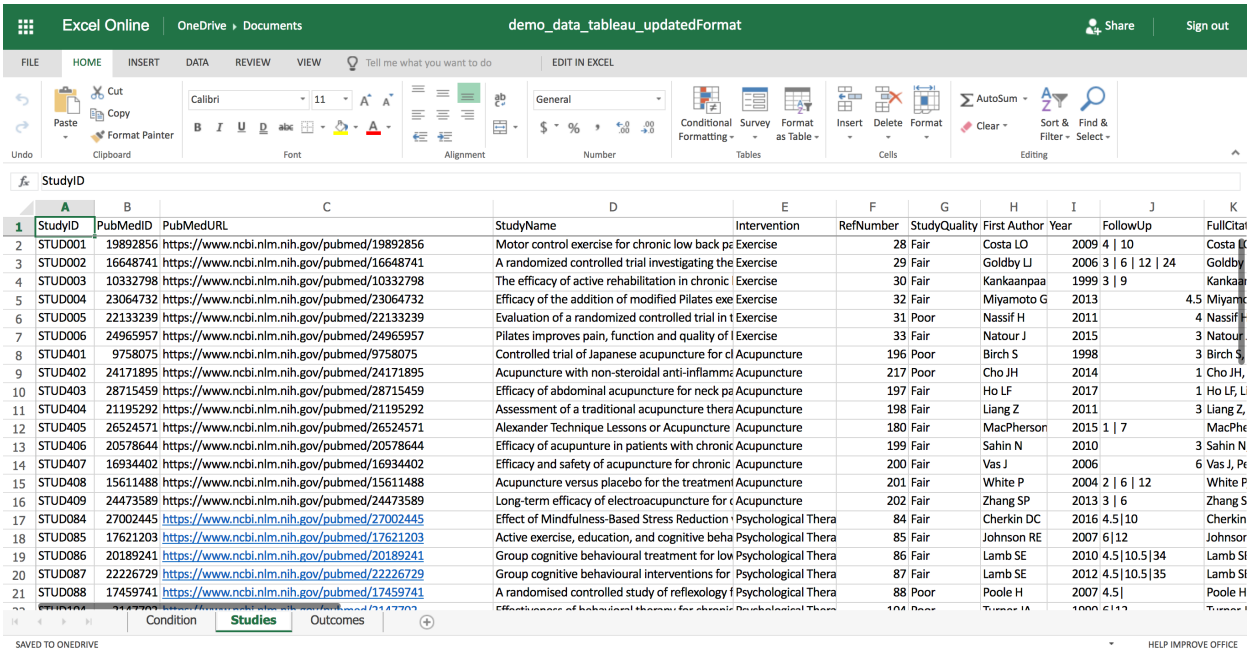
publication bias) with AHRQ Methods Guide domains (study limitations, directness, precision and reporting bias).

Tableau Prototype Development

Tableau was chosen to experiment with due to its capacity for graphical displays of data, wide range of support, and heavy saturation and use for business analytics and corporate reporting. The purpose of Tableau is to "help people see and understand data." and more information can be found at www.tableau.com. Tableau offers interactive data and graphical displays similar to STATSilk but does not run on Flash. We worked with members of their development team and were tasked with producing an excel sheet containing a sampling of our available data from the systematic review.

There is a learning curve when using Tableau and to help get users started, tutorials are available online. While it does not require programming skills, the person designing the application does need to learn how the program tools work. Familiarity with excel is also necessary as the visualizations and underlying dashboard rely on Microsoft Excel© workbooks used to create relational databases.

In order to use Tableau, we had to transform information from the pain report into an excel sheet that was formatted in a way that allowed the relationships among the variables we wished to display.



	StudyID	PubMedID	PubMedURL	StudyName	Intervention	RefNumber	StudyQuality	First Author	Year	FollowUp	FullCitat
2	STUD001	19892856	https://www.ncbi.nlm.nih.gov/pubmed/19892856	Motor control exercise for chronic low back pa	Exercise	28	Fair	Costa LO	2009	4 | 10	Costa L
3	STUD002	16648741	https://www.ncbi.nlm.nih.gov/pubmed/16648741	A randomized controlled trial investigating the	Exercise	29	Fair	Goldby LJ	2006	3 | 6 | 12 | 24	Goldby
4	STUD003	10332798	https://www.ncbi.nlm.nih.gov/pubmed/10332798	The efficacy of active rehabilitation in chronic	Exercise	30	Fair	Kankaanpaa	1999	3 | 9	Kankaa
5	STUD004	23064732	https://www.ncbi.nlm.nih.gov/pubmed/23064732	Efficacy of the addition of modified Pilates exe	Exercise	32	Fair	Miyamoto G	2013	4.5	Miyam
6	STUD005	22133239	https://www.ncbi.nlm.nih.gov/pubmed/22133239	Evaluation of a randomized controlled trial in t	Exercise	31	Poor	Nassif H	2011	4	Nassif H
7	STUD006	24965957	https://www.ncbi.nlm.nih.gov/pubmed/24965957	Pilates improves pain, function and quality of l	Exercise	33	Fair	Natour J	2015	3	Natour
8	STUD401	9758075	https://www.ncbi.nlm.nih.gov/pubmed/9758075	Controlled trial of Japanese acupuncture for cl	Acupuncture	196	Poor	Birch S	1998	3	Birch S
9	STUD402	24171895	https://www.ncbi.nlm.nih.gov/pubmed/24171895	Acupuncture with non-steroidal anti-inflamma	Acupuncture	217	Poor	Cho JH	2014	1	Cho JH,
10	STUD403	28715459	https://www.ncbi.nlm.nih.gov/pubmed/28715459	Efficacy of abdominal acupuncture for neck pa	Acupuncture	197	Fair	Ho LF	2017	1	Ho LF, L
11	STUD404	21195292	https://www.ncbi.nlm.nih.gov/pubmed/21195292	Assessment of a traditional acupuncture thera	Acupuncture	198	Fair	Liang Z	2011	3	Liang Z,
12	STUD405	26524571	https://www.ncbi.nlm.nih.gov/pubmed/26524571	Alexander Technique Lessons or Acupuncture	Acupuncture	180	Fair	MacPherson	2015	1 | 7	MacPhe
13	STUD406	20578644	https://www.ncbi.nlm.nih.gov/pubmed/20578644	Efficacy of acupunture in patients with chronic	Acupuncture	199	Fair	Sahin N	2010	3	Sahin N
14	STUD407	16934402	https://www.ncbi.nlm.nih.gov/pubmed/16934402	Efficacy and safety of acupuncture for chronic	Acupuncture	200	Fair	Vas J	2006	6	Vas J, Pe
15	STUD408	15611488	https://www.ncbi.nlm.nih.gov/pubmed/15611488	Acupuncture versus placebo for the treatment	Acupuncture	201	Fair	White P	2004	2 | 6 | 12	White P
16	STUD409	24473589	https://www.ncbi.nlm.nih.gov/pubmed/24473589	Long-term efficacy of electroacupuncture for c	Acupuncture	202	Fair	Zhang SP	2013	3 | 6	Zhang S
17	STUD084	27002445	https://www.ncbi.nlm.nih.gov/pubmed/27002445	Effect of Mindfulness-Based Stress Reduction	Psychological Thera	84	Fair	Cherkin DC	2016	4.5|10	Cherkin
18	STUD085	17621203	https://www.ncbi.nlm.nih.gov/pubmed/17621203	Active exercise, education, and cognitive beha	Psychological Thera	85	Fair	Johnson RE	2007	6|12	Johnsor
19	STUD086	20189241	https://www.ncbi.nlm.nih.gov/pubmed/20189241	Group cognitive behavioural treatment for low	Psychological Thera	86	Fair	Lamb SE	2010	4.5|10.5|34	Lamb SI
20	STUD087	22226729	https://www.ncbi.nlm.nih.gov/pubmed/22226729	Group cognitive behavioural interventions for	Psychological Thera	87	Fair	Lamb SE	2012	4.5|10.5|35	Lamb SI
21	STUD088	17459741	https://www.ncbi.nlm.nih.gov/pubmed/17459741	A randomised controlled study of reflexology f	Psychological Thera	88	Poor	Poole H	2007	4.5|	Poole H

Figure 8: Base Excel sheet for Tableau dashboard

We created sheets for condition, outcome, and study by retyping all of the relevant data from the PDF and Microsoft Word copies of the systematic reiew into a Microsoft Excel file. The condition sheet listed all of the different types of pain in the Pain report with columns containing the data for each condition. The study sheet had a row for each of the studies used in the report with each adjacent column containing data from each study. we included the following:

PubMedID, intervention category, first author and year, intervention category, quality rating, reference number in the original report, follow-up term, and full citation.

The outcomes sheet separated each outcome by intervention, type of pain (low back pain, neck pain, etc.), type of intervention (exercise, physical therapy, etc.), type of outcome (on pain or on function) and time period of outcome measurement (short, intermediate, or long).Each row was for a single outcome and columns were used to store the relevant data for that outcome. We added links to the studies and conditions of each outcome.

For our project, we purchased a yearlong license for the project. The pricing varies based on industry/site and their licensing programs. The Tableau dashboard, made up of all the excel sheets with the data directly from the report, was designed in Tableau Desktop and required the purchase of a Tableau Creator license.

We used the following column headers to sort information extracted information into the sheets we would create for Tableau:

StudyID	EffectOn (effect on pain or function)
PubMedID	Scale
StudyName	Total_N (total study population)
Intervention	FollowUp (follow up in months)
InterventionSpecifics (type of intervention)	Control_N (population of control group)
StudySize	Control_Mean (mean for control group)
RefNumber (reference number from pain report)	Control_SD (standard deviation for control group)
StudyQuality	Inter_N (population of intervention group)
FirstAuthor	Inter_Mean (mean for intervention group)
Year	Inter_SD (standard deviation for intervention group)
FollowUp (follow up time period)	
FullCitation	SMD (standard mean difference between control and intervention group)
Outcome (study outcome by pain and time interval)	ConfInt_low (confidence interval low range)
OutcomeID	
ConditionID (identifies pain or condition)	ConfInt_high (confidence interval high range)
Term (short, intermediate, or long)	

We started by making a summary sheet for our dashboard that included the pooled data across the included studies for each intervention for Chronic Low Back Pain. We chose to keep the visualization similar to the forest plots normally found in systematic reviews. We did this using a Gantt styled bar chart with a scatter plot. The scatter plot filled a circle on the horizontal axis. We chose to pool the outcomes using condition, intervention, comparison, effect (outcome) and term of effect as variables. These are on the left side and separated vertically. This would set the foundation for allowing users to select an outcome based on term of effects or to see outcomes for a condition across the types of interventions. Next, we provided text and messaging in a pop-up window to provide summary information about the pooled estimate and the included studies.

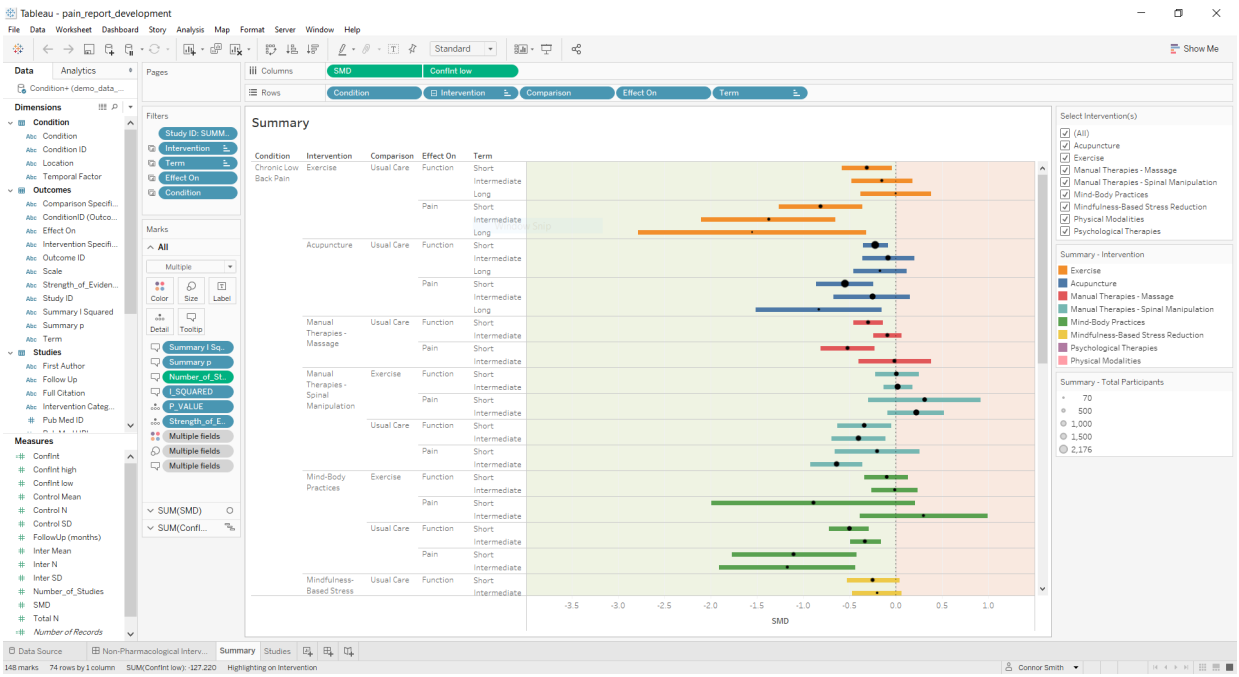


Figure 9: Tableau summary sheet development

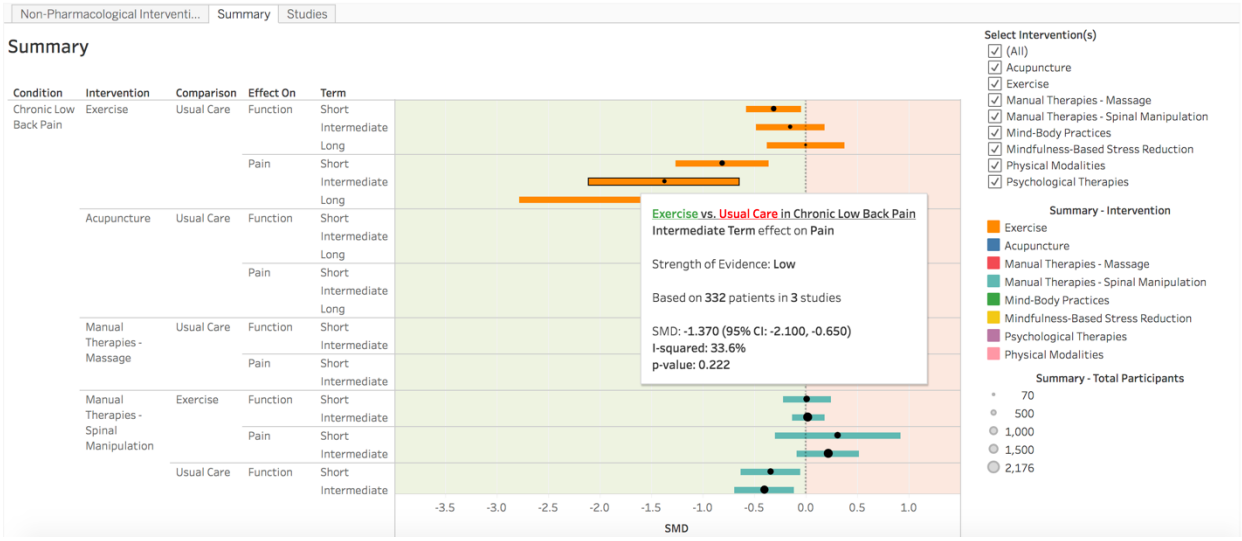


Figure 10: Tableau summary sheet with pop-up to provide extra detail

The dat analyst repeated this process for the individual studies on the study sheet. There was no pooling involved for those. That created records for every outcome from every study used in the report. Now, a one to many relationship existed between each study and the outcome pooled estimates. We again created a pop-up box to give users more detailed information on each study and included PubMed references.

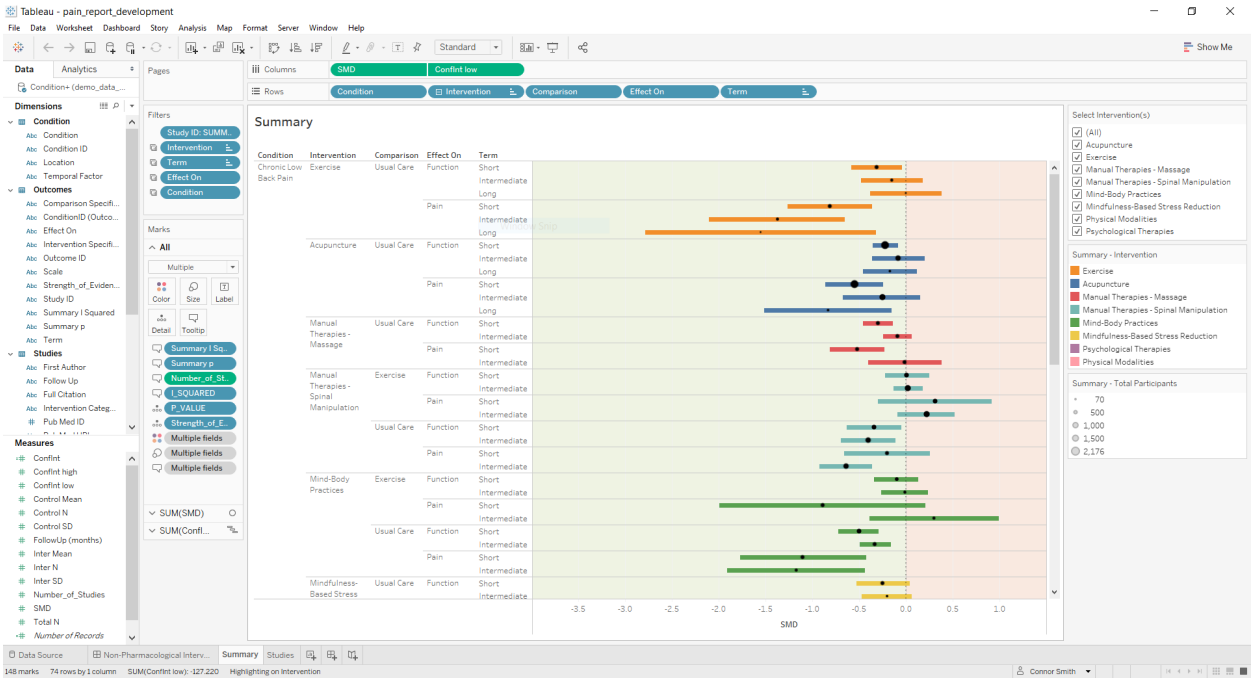


Figure 11: Tableau studies sheet in development

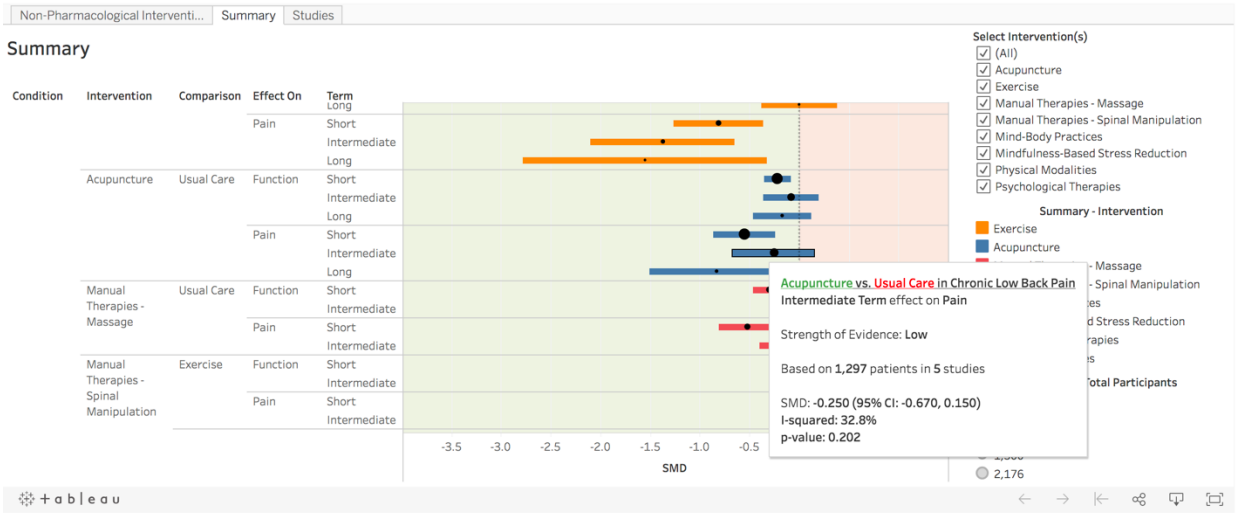


Figure 12: Tableau studies sheet with pop-up to provide extra detail

The pooled and un-pooled data reports from the summary sheets were combined to make the dashboard. The team added filters for each variable, condition, intervention, comparison, effect and term of effect, as well as legends to provide supplemental information about interventions and study sizes. For the last step we added a filter by Studies section, which enabled users to see any individual study or any outcome associated with a pool estimate. This finally allowed users the flexibility to see any combination of outcomes across any of the variables created earlier. This “slice and dice” function was one of the key features we coveted and wanted to bring to users to increase usability and effectiveness of data.

Below, Figure 13 represents our final dashboard for the report. Users can slice and dice the information from the studies used in the AHRQ pain report to compare interventions across

specific or multiple conditions (e.g. low back pain or low back pain and chronic neck pain), by effect (on pain or function), by intervention (acupuncture, intervention, and etc.) and by term (short, intermediate, and long). Users can use the slice and dice ability of Tableau to compare interventions across multiple variables.

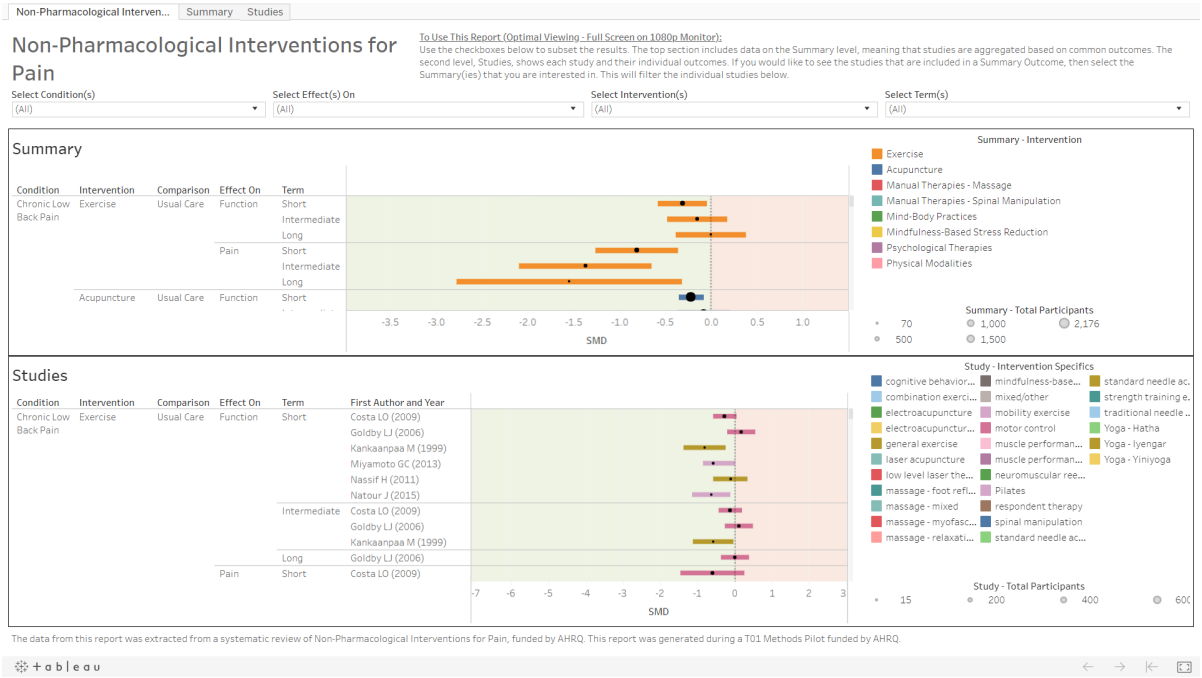


Figure 13: Tableau dashboard prototype complete

Phase 4: Evaluation of Prototypes

To gain insight into the guideline development process, we demonstrated our prototypes to the physicians we previously interviewed at the beginning of the project. for Oregon Health and Science. 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 if either prototype would be helpful developing guidelines and if there were areas that could be improved.

The general consensus among interviewees and the other stakeholders we presented the prototypes to was that comparative effectiveness reviews were useful but that clinicians and guidelines users primarily need answers "up front" but still need the ability to drill down for further detail if they choose. Each of the prototypes addressed some of these concerns.

After we developed spoke to the original interviewees, we showed the prototypes to potential users and stakeholders to gain feedback and buy-in. We conducted a presentation with Dr. Elizabeth Crabtree before she left OHSU to fulfill a new role. We were instructed to contact her replacement, Dr. Stephanie Halvorson, who was one of the original interviewees in the beginning of the project. We also worked with two staff members at the Office of Clinical Integration and Evidence-based Practice and presented our prototypes at the AHRQ EPC-V Annual In-person Meeting in Baltimore that occurred on May 2018.

We conducted half an hour, one-on-one unstructured interviews to gain insights on the usability of our prototypes. These presentations all reviewed the purpose of the project and demonstrated the two prototypes. The respondents were asked to describe their initial impressions and discuss what might be the most appropriate setting for their use.

The feedback we received about the prototypes and software was overall positive. Respondents enjoyed both the potential functionality of each application but also the aesthetically pleasing visualizations. Respondents said two important considerations would be 1) the level of expertise and knowledge of the end user and 2) the technical skill of the research staff compiling the review data.

To make a useful product, it was necessary to consider each user's differing levels of familiarity and ability to interpret evidence. In regard to the software's capabilities, one respondent noted that, "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 guideline developer had similar views and commented that having two products would allow investigators to formulate answers and provide useful information for local needs. The audience felt Tableau catered more towards content experts who may have questions about a subset of the overall data while MAGICapp was useful as a comprehensive tool because its framework followed the report and helped maintain the reports structure of key question and important section headers.

MAGICapp was regarded for its potential usefulness to groups developing guidelines because it addresses both the quality and strength of evidence across each question. Respondents commented about MAGICapp's ability to provide high level overviews, (e.g. information by key question) while still providing further details by "drilling down" into the studies and results (e.g. the specific study or report that support each key question). The functionality of the MAGICapp platform can provide health care professionals with information for a smooth transition from evidence to recommendations and provides direct links to the supporting studies and reports. Content experts expressed that things should be simple and that a list of key questions with the ability to expand on each question helps. The content experts felt that with the MAGICapp structure and PubMed links, users could decide to dig deeper if they felt the information was relevant. Another respondent felt MAGICapp fit well with the format of AHRQ reports. One respondent noted that the exclusion of a PICOT table was odd for them but that might not matter for other non-academic clinicians.

Drs. Crabtree and Halvorson expressed a preference for Tableau and commented specifically on the visual graphics that were developed for the pain outcomes. The graphics particularly stood out against the dense text found in the reports. Dr. Crabtree noted that Tableau could be useful at all levels of the organization. She gave an example of how a hospital administrator choosing which inpatient services to cover, "massage versus vs acupuncture, you can see that versus trying to find it in the report." Beyond a guideline committee's needs, another respondent noted that with Tableau it was possible to explore data based on local needs and questions. The respondent noted that you can ask different questions for patients and look at the data in different ways using Tableau. The search functionality was also praised as a useful tool for guideline committees who wanted to use the data to answer questions that might differ from the exact questions formulated by the researchers creating the systematic review.

Lastly, Tableau's visual format was perceived by content expert to be more useful for guideline development. They noted that sharing information across geographical locations (as Tableau

dashboard are stored publicly or privately on remote servers) and that the visualizations could be a “quick way to convince someone of your point.” The respondents noted that using more popup boxes to provide supporting information such as specific population characteristics or strength of evidence ratings would improve usability.

After the presentations for our prototypes were complete, one common question from all the respondents was about the amount of effort and resources work to get reports and evidence summaries into each application. MAGICapp was less time and resource draining up front but content experts questioned the software’s ability to represent overlapping studies or dual-review data abstractions. For Tableau, there were comments about needing to add or have team members with database knowledge as well as data presentation and dissemination skills. Conversely, other comments included openness and acceptance of data storage habits and information governance. Tableau and MAGICApp both gave the impression that they would be continuing development and available for the foreseeable future.

It was apparent that although each product had its strengths, neither product fully supported the all the needs of guideline developers, clinicians and policy makers. However, when employed in the right context, each product provided its users with the ability to manipulate the data in some form or fashion that supported their needs, in ways that were not possible using only a paper or pdf version of the report.

Summary and Conclusions

Based on a review of the available literature, systematic reviews are resource intensive undertakings that have the potential to expand their utility and impact by considering electronic formats for presentation and dissemination. Although SRs contain valuable information for decision making, systematic reviews draw conclusions from a broad set of evidence, but often present the information in one of may possible ways. We feel that using the prototypes developed for our pilot project, it is possible to subset information more efficiently and appropriately, allowing different users to use the data for different task at hand. The software applications we tested, MAGICapp and Tableau allow users to view data in the context of a specific question or local need by allowing them to “drill down’ or “slice and dice” the large amounts of data and information generated in conducting a systematic review.

We selected two different products, MAGICapp and Tableau to satisfy some parts of each of our different needs. To successfully utilize MAGIC App for our purposes, we had to modify how information in the pain report was presented and had to import our pain report as an evidence summary. For MAGIC App, the report was separated by the type of pain with each intervention and its outcomes listed as subsections beneath it. This allowed users to get a highlevel overview of the outcomes of the report while giving them the ability to drill down to more granular and specific data for each study.

Tableau was important for the flexibility and robustness of its capabilities to display many pieces of information at once. Although Tableau does have a learning curve, any professional can learn it. Tableau had a very big impact on how we were able to slice and dice the information from our evidence summary. It was a great compliment to the structure and form of MAGICApp. Tableau would be used to display the graphical and scientific data related to the actual reviews. We wanted to use tableau to provide information on the study outcomes as well as to provide

additional information such as population size, the types of interventions, the types of pain at glance or via hover over.

Although each application can be used individually, for our needs both applications working in tandem provided the best results. Where MAGICapp is structured and rigged, Tableau is flexible and dynamic. We feel both applications together can help make systematic reviews more usable for learning health systems, providers, policy makers and patients.

The team felt there were many ways to creatively yet accurately present information to guideline developers, clinicians and other audiences but the idea of presenting information in "layers" or in multiple dimensions" was most appealing because it reflects the current trends in information analytics. Instead of being presented with static information in the form of text or flat charts and graphs, we felt an interactive visual display of information would improve efficiency and enhance information usability for now and in the future.

Our final products are listed below:

- MAGIC APP – https://app.magicapp.org/app#/evidence-summary/150 (MAGICapp)
- TABLEAU – https://public.tableau.com/profile/connor.jp.smith#!/vizhome/AHRQT01MethodsPilot-PacificNorthwestEPCV2_1/Non-PharmacologicalInterventionsforPain?publish=yes

Below is a table highlighting the pros and cons of each:

Software	MAGICapp	Tableau®
Benefits	• Web based, easy to set up and use • Similar structure to EPC reports • Easy format allows for detailed narratives • Provides great detail on individual studies • An evidence "ecosystem," connecting evidence summaries with guidelines and clinical decision models • Internationally recognized, works with the BMJ, Cochrane, and etc. • Free and publicly available, accessible from any location with internet	• Flexible display of information, datasets can be explored based on context of the questions needing answers • Dashboards are updated in real-time • Visual overlay of information reducing the need for narrative text • Dashboard designs can be saved and shared across organizations as templates • Widely spread use for healthcare business analytics and real-time monitoring • Dashboards can be made free and publicly available
Limitations	• Structure is fixed and rigged • Narratives can become dense depending on content • Presentation not conducive to • Reference management requires some manual input • Uses GRADE methods and criteria, not AHRQ	• High level of technical skill needed for set up • less detail for individual studies used in dashboard • data can be difficult to display if it does not fit in traditional lines, graph or charts • limited production of narrative content
Considerations for future use	• EPCs will have to revise data standards and procedures to ensure ease of information transfer • MAGICapp will have to fix errors with importing batch references • AHRQ will need to approve EPC investment in MAGICapp for 'strength of evidence' criteria to be added to platform or switch to GRADE	• EPCs will have to revise data standards and procedures to ensure ease of information transfer • EPCs may want to consider guidance on statistical measures, population characteristics and strength of evidence ratings • Work with Tableau to create custom EPC formats or templates • EPC will have to hire or invest in staff training for Tableau

Challenges and Recommendations

Because of the wealth of information available to health systems today and the growing need for real-time, trustworthy information, we recommend that more resources be concentrated in the area of information dissemination. We assert that despite the large body of literature surrounding the implementation of clinical information for evidence-based learning and decision making, the implementation of evidence is much more well covered than its dissemination.

The need for usable and effective information grows more important with every piece of data that is generated and collected by the learning health system. More focus should be placed on studying effective information dissemination practices and the development of an information dissemination framework and guidelines. We recommend utilizing the same or similar software applications to supplement the current gaps in information dissemination and usability.

REFERENCES

1. In: Smith M, Saunders R, Stuckhardt L, McGinnis JM, editors. Best Care at Lower Cost: The Path to Continuously Learning Health Care in America. Washington (DC)2013.

2. Slutsky J, Atkins D, Chang S, Collins Sharp B. Comparing Medical Interventions: AHRQ and the Effective Health Care Program In: Methods Guide for Effectiveness and Comparative Effectiveness Reviews. [Internet]. Rockville, MD: Agency for Healthcare Quality and Research; 2008- [Available from: https://www.ncbi.nlm.nih.gov/books/NBK47092/.

3. Issues Overview for Observational Studies in Clinical Research. Observational Studies in a Learning Health System: Workshop Summary. Washington (DC)2013.

4. AHRQ. About AHRQ [Web Page]. Rockville, MD: Agency for Healthcare Research and Quality; 2017 [updated November 2017. Available from: https://www.ahrq.gov/cpi/about/index.html.

5. AHRQ. Effective Health Care Program History Rockville, MD: Agency for Healthcare Quality and Research; [cited 2018 September 03 2018]. Available from: https://effectivehealthcare.ahrq.gov/about/history.

6. OHSU. Pacific Northwest Evidence-based Practice Center - About Us Portland, OR: Oregon Health and Science University; 2018 [Available from: https://www.ohsu.edu/xd/research/centers-institutes/evidence-based-practice-center/about/.

7. Bodenheimer T, Sinsky C. From triple to quadruple aim: care of the patient requires care of the provider. Ann Fam Med. 2014;12(6):573-6.

8. Moore G, Redman S, D'Este C, Makkar S, Turner T. Does knowledge brokering improve the quality of rapid review proposals? A before and after study. Syst Rev. 2017;6(1):23.

9. Haby MM, Chapman E, Clark R, Barreto J, Reveiz L, Lavis JN. What are the best methodologies for rapid reviews of the research evidence for evidence-informed decision making in health policy and practice: a rapid review. Health Res Policy Syst. 2016;14(1):83.

10. Snilstveit B, Vojtkova M, Bhavsar A, Stevenson J, Gaarder M. Evidence & Gap Maps: A tool for promoting evidence informed policy and strategic research agendas. J Clin Epidemiol. 2016;79:120-129.

11. Tricco AC, Lillie E, Zarin W, O'Brien K, Colquhoun H, Kastner M, et al. A scoping review on the conduct and reporting of scoping reviews. BMC Med Res Methodol. 2016;16:15.

12. Tsertsvadze A, Chen YF, Moher D, Sutcliffe P, McCarthy N. How to conduct systematic reviews more expeditiously? Syst Rev. 2015;4:160.(doi).

13. Aromataris E, Fernandez R, Godfrey CM, Holly C, Khalil H, Tungpunkom P. Summarizing systematic reviews: methodological development, conduct and reporting of an umbrella review approach. Int J Evid Based Healthc. 2015;13(3):132-40.

14. Vogel JP, Oxman AD, Glenton C, Rosenbaum S, Lewin S, Gulmezoglu AM, et al. Policymakers' and other stakeholders' perceptions of key considerations for health system decisions and the presentation of evidence to inform those considerations: an international survey. Health Res Policy Syst. 2013;11:19.

15. Lavis JN, Wilson MG, Grimshaw JM, Haynes RB, Hanna S, Raina P, et al. Effects of an evidence service on health-system policy makers' use of research evidence: a protocol for a randomised controlled trial. Implement Sci. 2011;6:51.

16. Orton L, Lloyd-Williams F, Taylor-Robinson D, O'Flaherty M, Capewell S. The use of research evidence in public health decision making processes: systematic review. PLoS One. 2011;6(7):e21704. doi: 10.1371/journal.pone.0021704. Epub 2011 Jul 26.

17. Rosenbaum SE, Glenton C, Wiysonge CS, Abalos E, Mignini L, Young T, et al. Evidence summaries tailored to health policy-makers in low- and middle-income countries. Bull World Health Organ. 2011;89(1):54-61. doi: 10.2471/BLT.10.075481. Epub 2010 Nov 24.

18. Yousefi-Nooraie R, Rashidian A, Nedjat S, Majdzadeh R, Mortaz-Hedjri S, Etemadi A, et al. Promoting development and use of systematic reviews in a developing country. J Eval Clin Pract. 2009;15(6):1029-34.

19. Jbilou J, Amara N, Landry R. Research-based-decision-making in Canadian health organizations: a behavioural approach. J Med Syst. 2007;31(3):185-96.

20. Dobbins M, Jack S, Thomas H, Kothari A. Public health decision-makers' informational needs and preferences for receiving research evidence. Worldviews Evid Based Nurs. 2007;4(3):156-63. doi: 10.1111/j.741-6787.2007.00089.x.

21. Pope C, Mays N, Popay J. How can we synthesize qualitative and quantitative evidence for healthcare policy-makers and managers? Healthc Manage Forum. 2006;19(1):27-31.

22. Chan KS, Morton SC, Shekelle PG. Systematic reviews for evidence-based management: how to find them and what to do with them. Am J Manag Care. 2004;10(11 Pt 1):806-12.

23. Perrier L, Mrklas K, Shepperd S, Dobbins M, McKibbon KA, Straus SE. Interventions encouraging the use of systematic reviews in clinical decision-making: a systematic review. J Gen Intern Med. 2011;26(4):419-26.

24. Perrier L, Kealey MR, Straus SE. An iterative evaluation of two shortened systematic review formats for clinicians: a focus group study. J Am Med Inform Assoc. 2014;21(e2):e341-6.

25. Perrier L, Kealey MR, Straus SE. A usability study of two formats of a shortened systematic review for clinicians. BMJ Open. 2014;4(12):e005919.

26. Petkovic J, Welch V, Jacob MH, Yoganathan M, Ayala AP, Cunningham H, et al. The effectiveness of evidence summaries on health policymakers and health system managers use of evidence from systematic reviews: a systematic review. Implement Sci. 2016;11(1):162.

27. Tricco AC, Cardoso R, Thomas SM, Motiwala S, Sullivan S, Kealey MR, et al. Barriers and facilitators to uptake of systematic reviews by policy makers and health care managers: a scoping review. Implement Sci. 2016;11:4.(doi).

28. Wallace J, Byrne C, Clarke M. Improving the uptake of systematic reviews: a systematic review of intervention effectiveness and relevance. BMJ Open. 2014;4(10):e005834.

29. Oliver K, Innvar S, Lorenc T, Woodman J, Thomas J. A systematic review of barriers to and facilitators of the use of evidence by policymakers. BMC Health Serv Res. 2014;14:2.(doi):10.1186/472-6963-14-2.

30. Schoelles K, Umscheid CA, Lin JS, Concannon TW, Skelly AC, Viswanathan M, et al. A Framework for Conceptualizing Evidence Needs of Health Systems. AHRQ Methods for Effective Health Care. Rockville (MD)2017.

31. The Grade Working Group. Welcome to the GRADE working group [Web page]. 2018 [Available from: http://www.gradeworkinggroup.org/.