Collaborative Endeavors: A Team Perspective on Co-authoring Systematic Reviews with Medical Students

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Abstract

Introduction: Evidence synthesis (ES) projects have been on the rise, providing a way to work collaboratively without needing to use a lab or meet in person. ES projects are a good method for all involved to learn more about the subject, to foster meaningful collaborations among team members, and to establish and improve mentoring skills. The authors conceptualized, formulated, drafted, and published a diagnostic accuracy systematic review on rapid antigen tests used to detect COVID-19. During the review, varied challenges arose, many unanticipated. To address them the authors and team members developed effective strategies that may benefit future ES projects.

Experience: The article describes the experiences of the varied team members, which included medical students, a librarian, faculty, and a data analyst. The article addresses the collaborative process including defining roles and responsibilities. Next, the authors describe laying the foundation of the project so that as team members were recruited, the project flowed smoothly. The team then reflects on the management of the project over multiple years. As with many ES projects, the protocol needed to be revised, and the authors share their approach to these changes.

Discussion: The librarian's collaboration with both students and faculty members yielded significant benefits, including improved mentoring skills, enhanced team coordination, and diverse perspectives gained through interdisciplinary collaboration. The challenges faced by navigating the literature landscape and managing the team are also described.

Takeaways: Librarians are in a unique position to advocate for multi-disciplinary teams, incorporating a data analyst early on, and judiciously using software in evidence synthesis projects. These projects help build the backbone of medical literature.

Introduction

There has been an uptick in publishing evidence synthesis projects such as systematic and scoping reviews[1], particularly since the start of the pandemic in 2020, as evidenced by a search for the phrase 'systematic review' in the record titles in PubMed, which showed 73,559 results from 2015-2019 and 165,216 from 2020-2025. Similarly, the search for the phrase "scoping review" in PubMed, showed 3,455 results for 2015-2019 and 25,406 for 2020-2025, (the search was conducted on Jan 15, 2025). Evidence synthesis (ES) projects provide an avenue for students and faculty to publish, for mentorship (student/faculty, student/student, and faculty/faculty), and for all involved to learn more about the process of and participation on a team project. In a recent effort to write a systematic review on the diagnostic accuracy of rapid antigen tests for COVID-19 detection (full review published in Oct 2024[2]; protocol published in 2021[3]) a range of challenges were encountered, many of which were unanticipated, such as issues with published studies, challenges coordinating and training a large group, and deciding how to organize files and tasks. The authors developed methods to streamline the work that they feel may benefit a larger group. The faculty (six in total) on the team coordinated a large group (11 in total) of osteopathic medical students to complete this project. The methods used to keep the project moving forward included dedicated work time, piloting each step of the process, and assigning students specific numbers of papers to review. Additionally, the team used collaborative spreadsheets with

Google applications (Alphabet, Inc). Here, we present some challenges of completing a systematic review of diagnostic test accuracy and some tips and tricks for mentoring a large group of students.

Systematic reviews offer a rigorous research methodology that contributes to improving practices and institutional research footprints. The cost of foundational science, translational, and clinical research continues to increase due to the cost and access to reagents, equipment, and specialized facilities. While the cost of journal subscriptions and article access continues to rise, the material costs for systematic reviews remain lower than lab or field-based biomedical research. This lower material cost is useful for institutions with more research demand than facilities.

In addition to material costs, faculty time and expertise are critical resources. The human power (personnel hours) needed to complete an evidence synthesis project is similar to, if not more than, foundational, translational or clinical research but without requiring reagents, equipment, and specialized facilities. However, training faculty members in systematic review methodology can exponentially increase the number of people capable of doing systematic reviews as they continue instructing trainees (students, residents, fellows). While training doesn't ensure high-quality research products, as is seen across many different fields, collaborations with library faculty can increase the integrity of evidence synthesis projects.

These aspects of resource investment and the potential amplification of initial training and skills make systematic reviews an option to help meet research demand. Institutions considering adding evidence synthesis projects to their research portfolio must consider training, labor, software, and article access before embarking on such endeavors.

Experiences

The Collaborative Process: Establishing roles and responsibilities
Librarian expertise in information sciences

Librarian expertise can be both broad and in-depth on evidence synthesis projects. This review didn't require any conceptualizing or brainstorming related to the research question, but often, this is something librarians can do in a team meeting when assisting with searching for existing reviews and studies on a topic to help shape and direct the research question for evidence synthesis. Our team had a clear question in the PIRD (population, index test, reference test, diagnosis of interest) framework, often used in diagnostic accuracy question development[4].

Librarians can competently identify databases and resources appropriate to search for the research question and are familiar with what is available at their institution and the resources freely available, including identifying grey literature resources. Developing and implementing search strategies for all resources is a prominent skill non-librarians think should be the role of librarians implementing evidence synthesis projects[5-7]. However, this time-consuming and valuable part of the project is one aspect of the librarian's contribution. A librarian colleague refers to it as developing the data collection instrument since the search strategy determines the articles to be screened.

Librarians are skilled and efficient at finding articles. Additionally, librarians know citation software and can assist and train the team in managing citations using a specified software, such as EndNote. For our project, this provided an opportunity to train students in article retrieval and citation management. The collaboration between the methods' expert (librarian) and the more accessible subject matter expert (trainees) helped enhance the development of the search strategy.

Medical students' clinical insights and research skills

Medical students provide a unique and diverse perspective on clinical topics as they are new to the field. They benefit from seeing clinical challenges with new eyes since they begin their journey to become clinicians. Students are more exposed to research methods earlier in their educational journey than ever before. This shift is driven by the increasingly competitive environments where trainees and potential trainees need to distinguish themselves from other applicants at each level of education[8,9] (undergraduate medical education and graduate medical education). Two of the students that the librarian worked closely with mentioned that the time spent with the librarian helped them in a residency interview and with one or two board exam questions. This early exposure in their undergraduate careers allows them to develop and refine their research skill sets before they matriculate into medical school[10,11]. Further, the technological and internet literacy many of today's students have is a clear result of their lived experiences where the internet and computers have always been available[12,13]. These are invaluable skills to leverage as they may be able to develop new techniques and approaches that utilize technology in innovative ways.

The spectrum of roles for medical students in writing a systematic review can range from data collection and entry to foundational team members who contribute intellectually and technically to the entire process. We empowered our student team to explore the range of potential roles within the project and find where they felt comfortable contributing. A few of our students stepped up into the foundational team member roles, where the project relied on their involvement to proceed. For example, one of our earliest students helped write the protocol as well as piloted the reference deduplication process, the title/abstract screening, the full-text screening, and the risk of bias process before helping teach the other students on the team. A different student was content to pull data from the selected articles but did not have the time to pilot or develop processes for the review. When embarking on a project such as this, it is important to help students define their roles and responsibilities.

Faculty roles of mentorship, guidance, and content expertise

Depending on the project's goals, the spectrum of faculty roles can be as broad as those for medical students. The faculty's main responsibilities are to promote student learning and collaboration, including accountability and professionalism, to ensure the integrity of the research, to ensure equitable treatment of all project team members, and to identify the needed expertise for the execution of the project.

The faculty members need to take responsibility for the equitable treatment of all members of the project team. This entails both ensuring that the members know and uphold their responsibilities (accountability), and that team members interact in respectful ways (professionalism). These aspects should be specifically detailed in the working agreement

(see Appendix 1). Some trainees struggle with both aspects and can become unprofessional when they fail to see the value of multidisciplinary approaches or become overwhelmed with other activities. It is the faculty members' responsibility to highlight the value that each team member brings to the project and emphasize that research is not done in a vacuum but in an intricate network of expertise and perspectives.

The team recommends using written, living documents as practical advice for faculty members to handle these roles and responsibilities. These documents are collaboratively written by the faculty and students that detail the expectations, roles and responsibilities, and timelines for the project. The team recommends a living document so that updates can be made as the project or team changes, and the agreements within the document can be revisited and discussed at each project milestone. Flexibility is a component of professional life and our agreements and roles within these projects should remain flexible. There are many different templates of these types of documents available, and the version selected should be tailored to the project and its personnel. When developing the roles and responsibilities for this project, the faculty members discussed the project, expectations, and timelines with each trainee individually and collaborated on desired contribution levels and expectations. In the end, the final working agreement (Appendix 1) that was collectively agreed upon allowed accountability, professionalism, and timely project completion.

Data scientists' roles in project design, and analysis methodology

The data scientist should be incorporated throughout the project with specific roles in three main stages, the first being the protocol writing stage. They can help identify the type of data that needs to be collected to answer the review question. For example, in a diagnostic accuracy review, our data scientist recommended additional data for sub-group analysis beyond test accuracy values. They can design the data collection instrument so that the extraction process runs smoothly. For example, we modified our data collection instrument to use standardized terminology, which helped with the meta-analysis. The second stage is the data extraction process and meta-analysis. Someone with a statistics background was essential for these steps of the review. The data analyst helped the team identify papers that did not report outcomes needed for meta-analysis. Additionally, they made informed decisions on the types of statistical techniques implemented. For example, due to the high heterogeneity of the data, the data scientist guided the methodological shifts to the meta-analysis.

The final stage is data presentation and sharing. The data scientist can ensure that technical methodology and results are well described in the manuscript. They can also help make data publicly available on repositories such as GitHub. For our project, they were integral in the writing and submission of the manuscript.

Laying the foundation of the project

A well-designed ES project starts with a detailed protocol and a librarian-driven comprehensive search strategy. The protocol drafting and submission was headed up by the team librarian with assistance from two of the medical students. The medical students began with the pre-written template from JBI methodology (formerly known as Joanna Briggs Institute, Adelaide, Australia[4]) and worked with the librarian to test, refine, and clarify the

research question, inclusion/exclusion criteria, and the results from the search strategy. In this step, the librarian served as the main mentor of the students and the project.

The search strings for COVID and for the Rapid Antigen tests were initially drafted by the librarian and then refined with the help of the students. They quickly learned that there were validated searches that existed for COVID, which formed the basis for the protocol's search strategy. This was tricky since most of the strategy was drafted in 2020, before the codification of COVID terms. In January 2021, as part of the annual changes in MeSH (Medical Subject Headings) by the National Library of Medicine, many of the COVID indexing terms were upgraded from being Supplemental Concepts to being MeSH terms. Due to this, the search had to be extensively revised with the new MeSH terms. Additionally, following PRESS (Peer-Review of Electronic Search Strategies) guidelines[14] helped give structure to the search and its revisions.

Managing the project

At its peak, the project had six faculty members and eleven students working on the project simultaneously. Managing this project required coordination across the faculty and the students to maintain consistency with individuals and prevent unnecessary redundancies. Throughout this project, the trainees and faculty were responsible for screening, critical appraisal, and data extraction. The faculty mentors kept the team on track and revised timelines as needed. The librarian was more heavily involved in retrieving full-text articles and screening. The data scientist served as a validator for the data extraction and performed the meta-analysis. Several strategies contributed to the success of managing this project with so many individuals.

The number one strategy employed to manage this project was to have a one-hour, optional but highly recommended, "working" meeting each week. As a team, we would meet virtually every Monday evening to work for an hour on the project. This provided a dedicated time on each person's schedule to contribute to the review, along with a level of accountability. Additionally, this provided a time to address concerns, inconsistencies, and clarify the tasks of each step in the review process. The students knew that the faculty would be expecting them to attend, and the faculty expected each other to be present. The first few minutes of each meeting were used to review the current tasks, update everyone on the progress of the project, and address any confusion or concerns. The last few minutes of each meeting were used to address goals, whether ongoing or for the upcoming week; discuss issues that may impact upcoming efforts, such as upcoming exams for the first- and second-year medical students; and to summarize the progress done in the meeting so far. As a tool to keep the project moving forward, this standing meeting ensured that at least a few hours of work were completed weekly regardless of our other time constraints. This prevented the project from getting lost in the "back burner" of responsibilities that we have as faculty and that our students have for their academic performance.

We utilized Google's collaborative software apps, Gdrive[15] and Gsheets[16], to manage the progress of our project. We recommend using open-source, collaborative, and cloud-based software as the home of your reviews-in-progress. This offers a low-cost alternative to expensive software packages. The Google collaborative software apps, which are cloud-based, allowed our group to access the materials anywhere at any time and see real-time

updates to the process.

For each step in the process of the review, we utilized a different, customized spreadsheet, details of which can be found in the published review[2]. These spreadsheets were generated by the faculty to be easy to use, easy to understand, and provide consistency across the project members. For example, we used prioritized drop-down boxes for our full-text screening that listed the criteria from most important reason to least important reason. Each line included the name of the person working on the item and the outcome of their assessment. We instructed the students to use the drop-down like a list of yes or no questions such that the first "no" they encountered would be the selected reason for exclusion. This helped increase the efficiency of the process by only selecting one exclusion reason even if multiple reasons were present. This also allowed easy collation of the exclusion reasons when we compiled the tables for the required appendices that list the reasons studies were removed from the review. As we moved forward on our review, we trained the group on how to use each spreadsheet.

While we had weekly meetings where we would discuss the methods to be used during the review process, there was rarely a week that everyone on the team could attend. To address this, we recorded the training discussions that occurred at the start of each new step. Once completed, the recording was uploaded into a shared Google Drive folder for everyone to access. This accomplished several goals, the first being that the absent members had access to the same visual and oral directions as other team members. Second, it allowed team members to go back and revisit the instructions as needed. Finally, it generated a record of each step and how the steps were completed.

The final key project management strategy that we used as part of this project was to loosely delegate tasks. The team discussed feasible metrics (e.g., number of article assessments) and deadlines. An example assignment to the students was to complete at least ten article assessments over the course of two weeks. We, however, did not assign specific articles to each student. Instead, the students identified the ten assessments they wished to do in those two weeks. This strategy kept students accountable for the work but did not call out students when they completed their assigned tasks. Occasionally, some students would be unable to finish the task by the deadline, but others would step in to help their peers. Providing the students with some structure and some flexibility increased the confidence, happiness, and productivity of our students throughout the project. However, flexibility with deadlines did cause delays in the project timeline.

Revising our protocol

As with any plan, our original published protocol did not survive its encounter with the systematic review itself. Several of the faculty collaborating on this project had completed the JBI training together and had discussed the project at length during that initial phase. Later, as we wrote the protocol with a few students, we further refined our thoughts. However, as more students were brought on, there became a distance between the ideation in the faculty's minds and the students' understanding of their tasks. Many portions of our protocol required tweaking with minor adjustments to match the reality of the work. We also encountered larger hurdles that required more substantial revisions to our protocol.

When we began working on our full-text screening, we quickly discovered that the phrasing

of our inclusion and exclusion criteria in our protocol did not match the goal of the research question. We had trained our students to follow the letter of the criteria, not the spirit. Thus, when a student and a faculty member served as the two reviewers for a specific article, there was a discrepancy between them on whether the article met the inclusion criteria or not. As more of these discrepancies appeared, we discovered the difference in interpretation of the protocol. As this posed a significant, critical point in the applicability of our study, we needed to revisit the protocol and clarify our methods. The faculty members on the team discussed the specifics and then discussed it with the students in the next meeting. The number of discrepancies decreased after such meetings. Changes made in the protocol were listed in the review as deviations from said protocol.

This experience taught us the importance of precision in our language and our directions to the students, as well as the importance of flexibility in our thinking. Shifting the criterion to better match our goal allowed many more studies to be included that would otherwise be excluded if we followed the letter of our protocol. This is important because we were able to garner additional information regarding our research question, increasing the power and strength of our study. It also demonstrated to the students that having this flexibility and documenting it is part of the research process.

Discussion

This project was the team's first major systematic review, and the librarian requested to be part of the entire process to gain a better footing and grounding in all steps involved in an ES project. The team recognizes that it was a unique situation (being the first review and the pandemic), and it is unlikely that the members would do the same for following ES projects. Librarians do not commonly participate this heavily in a review since they are ES methods experts and rarely have a background in the subject matter. This project enriched our understanding of librarian-medical student collaboration and highlighted the challenges in both the literature and multi-disciplinary collaborations.

Benefits of librarian-medical student collaboration

Taking the lead with the students on the protocol allowed the librarian to offer in-depth mentoring and training of the JBI methodology. It allowed for different teaching and training modalities with varying approaches of students, expertise, and skill levels. An unexpected benefit of having this time with a small group of students was that it allowed the librarian to have a greater understanding of medical students' time constraints, the ways students use databases, think and frame questions, and their mindset with resources and research. It helped the librarian be a better liaison by getting to know the users of the resources more intimately. Having less time now for hands-on small group training, our institution has subscribed to software (Covidence) that assists with this and for the librarian to work with colleagues to develop tailored materials for different steps of the process to allow for a less hands-on approach.

The librarian found in this project that working with students helped build their confidence and reflect on their understanding, which aided not only in the search but the writing of the protocol, and mentoring and training newly added students to the project. The students on this project were able to be more open and vulnerable with the librarian, than with other faculty.

Collaborating does take more time in some respects but ultimately benefited our team since all involved had a strong understanding of the question and the content being sought.

In contrast to our experience with this project, our librarians rely less on students and subject matter experts in developing searches. In their current projects, they usually meet with teams to discuss MeSH definitions and review entry terms as well as look over initial results and how to refine or revise the search to improve either sensitivity or precision. Other team members are often familiar with acronyms and synonyms unfamiliar to librarians and can often expand searches and assist with the effectiveness of the search.

Our institution has now implemented a tiered service model for ES projects with two tiers of consultant or author. The consultant role would PRESS the search developed by the team and provide feedback. The librarian in the author role would develop the search strategy and have another librarian PRESS it.

Working on ES projects with medical and health science students allows for in-depth collaboration and understanding of each other's roles and expertise. It benefits both the librarian and the student. The librarian can offer encouragement, help connect with faculty, listen and support by bringing questions to the group. Participating in ES projects boosts confidence in interacting professionally and strengthens subject knowledge and skills in writing and working collaboratively. For our team, it allowed for equalizing roles and faculty dictating tasks, but also identifying ways for students to participate and motivated them to seek out ways to contribute, taking into account their capacity and time limits.

Challenges encountered in the literature

One approach we used in this project was to modify a validated search. Some experts note that by modifying a validated search, it is no longer valid. However, search building for an ES project is an iterative and involved process. Modifying a validated search increased the efficiency of drafting and formalizing the searches for this project. Using a validated search as a starting point can be a valuable step in the search strategy development process. Every ES project's search improves as we learn more about the methods and our skills increase.

Another challenge in our systematic review of diagnostic accuracy was the lack of diagnostic data in many of the published studies. We expected all diagnostic accuracy studies to adhere to the STARD (Standards for Reporting of Diagnostic Accuray studies) guidelines[17] published in 2015 and set international standards for publishing and reporting on diagnostic accuracy studies. Many of the studies did not meet these standards, affecting the data extraction stage of the project. The data analyst on the project, being the second data extractor, noticed that while the medical and demographic data were extracted with accuracy, the numbers related to sensitivity and specificity were more difficult. The lack of adherence to STARD guidelines[17] made it hard to extract the underlying values for sensitivity and specificity. It required additional training for the students on how to obtain those values from the text of the paper as opposed to a table.

Challenges faced during collaboration

As anyone who has worked with pre-clinical medical students can attest, they are quite busy

and have difficulty focusing on extracurricular activities such as research. To combat this, we utilized a large team of students so that the work was distributed across multiple students, reducing the amount of work any individual student needed to complete. Our review took several years to complete (ideation in June 2020 to manuscript submission in July 2023), which meant that some of our students who joined the project early in the pandemic were graduating and moving on to their residencies before the review was completed. Due to the length of the project, the search was run in 2021 as well as in 2022. Additionally, we brought in new students who needed to be trained and mentored as the project continued.

Mentoring and training students is not an easy task, especially when you throw in the varying levels of experience the students bring into the project. It sometimes required individual meetings as well as additional videos for the students to be able to complete the project and their research experience successfully.

There is potential for these types of projects to put an undue burden on librarians to mentor and train students in the ES methodology. Again, the authors emphasize the need to define roles and responsibilities at the start of the project and have a clearly defined ES service model. There are students and faculty who are used to seeing librarians in a service role rather than as co-researchers and a full team member since their expertise and skill set are different from other faculty. The data scientist and librarian share this specialized research role on the team and sometimes need to discuss the intellectual contribution with other faculty and students, reminding them that it warrants rights and privileges on the project, such as authorship.

Takeaways

This project has reinforced the importance of fostering successful partnerships. To accomplish this, we have the following recommendations.

1. *Clear roles and responsibilities*

In our project, we defined roles and responsibilities based on tasks to be completed. The librarians brought expertise in information science, search design, protocol development, and ES methodology. Trainees bought their clinical insights and were responsible for screening and data collection. The faculty held leadership and mentoring responsibilities along with subject matter expertise. The data scientist led the statistical methods of the ES project. Expectations for authorship were defined and expressed to individuals who joined the project.

Moving forward, students would have a role in developing the research question. One potential method that could be used is to have the students write 2-3 research questions on a topic based on the acronym frameworks (PICO, PIRD, etc.). Then each student would look through various databases to determine what work was done on their topics and refine their questions. Finally, the team would collaboratively select a research question to pursue as a systematic review. Having an interdisciplinary team for ES projects, including a librarian, a subject matter expert, and a data scientist, is highly recommended. Each team member will bring a fresh outlook to the review question, inclusion-exclusion criteria as well as conclusions about the meta-analysis. The students on the team will also obtain experience with multiple disciplines, thus enhancing their research experience. Each discipline has

overlapping and unique roles within an ES project, which need to be clearly defined.

For many ES projects, it would be desirable to have someone fulfill the role of the data analyst. The person fulfilling the data analyst role would ideally have working knowledge of statistical models used within the subject matter. For example, in our project, decisions needed to be made about how to address the heterogeneity of the data and the effect of outliers which was outside the expertise of the other team members. Again, clarity of expectations from the individual fulfilling this role needs to be established early on.

2. *Ongoing communication and mutual respect*

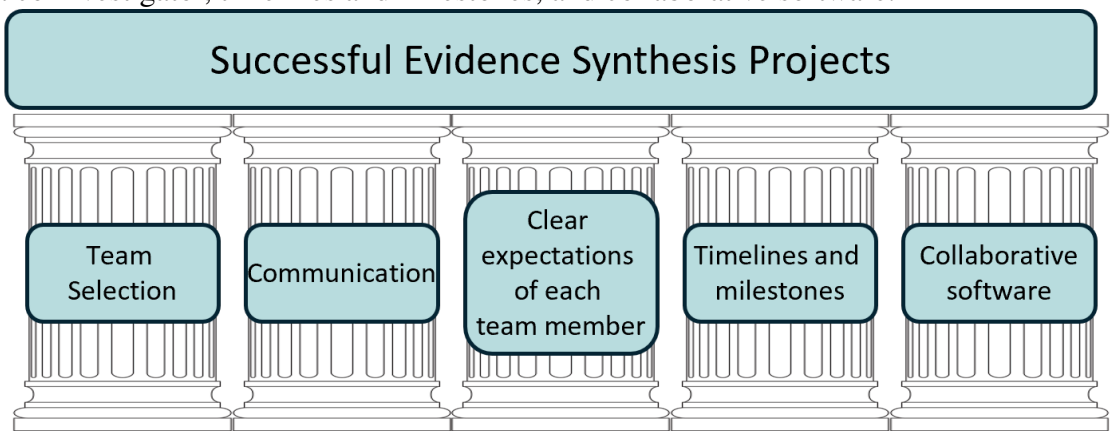
For any project with an interdisciplinary team, it is important to have healthy and ongoing communication between the team members to successfully complete the project. For our team, the weekly meetings provided a forum to discuss the project. Also, follow-up emails were used to summarize the meeting and ensure communication with the team members who missed the meeting. The team was actively encouraged to communicate in a way that suited them through inclusive language and various communication platforms. Decisions need to be made at each stage of the review and cannot be made arbitrarily by one person otherwise, that could lead to bias. Disagreements that occurred during screening involved discussions with different team members (trainees and faculty), where each team member was invited to share their opinion. Errors were acknowledged and addressed irrespective of who made them.

The selection of the team is critical to project success. The personalities of individuals and the team can radically impact the project's success. Expertise can be gained, but attitudes are harder to shift. It is vital to recognize each person's contribution to the project and respect the other's expertise and experience. The culture of mutual respect was established in the first meeting based on the faculty's interactions with each other and the students. The team also acknowledged and celebrated each member's worth as an individual, including achievements outside the project.

Conclusions

Our team encourages librarians who are interested in collaborative teams to be clear about their role and the team's expectations. It can be helpful to have a service model outlined so that it can be referenced. Overall, we had a good experience in completing our systematic review on the diagnostic accuracy of rapid antigen tests for COVID-19. Our success lies in our flexibility, clear communication, project management strategies, collaborative working spaces (live sessions and asynchronous), and commitment to high-quality, rigorous analysis and work (See Figure 1).

Figure 1. Pillars of successful evidence synthesis projects. Selection of a good team, regular communication, clear expectations of each team member, particularly the role of the librarian as a co-investigator, timelines and milestones, and collaborative software.



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