AHRQ CEDAR

Final Pilot Report

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Disclaimer of Conflict of Interest

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

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Introduction

The Agency for Health Research and Quality (AHRQ) disseminates patient-centered outcomes research (PCOR), and other research evidence and findings, into clinical practice through clinical decision support (CDS). The AHRQ Center for Evidence and Practice Improvement (CEPI) maintains public repositories of research evidence and PCOR findings. Those repositories include the Systematic Review Data Repository (SRDR), the Effective Health Care Program (EHC), CDS Connect, and recommendations from the U.S. Preventive Services Task Force (USPSTF). AHRQ recognizes a need for these repositories to be more findable, accessible, interoperable, and reusable (FAIR).[1]

The CMS Alliance to Modernize Healthcare (the Health FFRDC), operated by The MITRE Corporation (MITRE), supports the CEPI Evidence Discovery And Retrieval (CEDAR) project toward these goals. CEDAR developed a standards-based application programming interface (API) that disseminates findings from multiple CEPI repositories through a single location, making the repositories (and the evidence they contain) more FAIR.

As part of the CEDAR project, the Health FFRDC piloted the CEDAR API with the American Academy of Family Physicians (AAFP). This report provides an overview of the CEDAR pilot activities.

Pilot Scope

The CEDAR API enables users to search and access CEPI research evidence that exists in multiple repositories from one place, making it easier and faster to find and use evidence in research, quality improvement activities, and clinical practice. The technical specifications and details of CEDAR reference implementation (RI), including the CEDAR API, are described fully in the AHRQ CEDAR Final Project Report.[2] AAFP created and hosted "CEDAR Search," a client application prototype enabling pilot participants to interact with CEDAR's features and test the functionality of the CEDAR API.[3] A snapshot of CEDAR's concept of operations is included in Appendix A; this can help visualize where CEDAR Search engages with CEDAR.

MITRE undertook the following activities:

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[1] See, e.g., https://www.force11.org/group/fairgroup/fairprinciples and Wilkinson, M., Dumontier, M., Aalbersberg, I. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci Data 3**,** 160018 (2016). https://doi.org/10.1038/sdata.2016.18.

[2] AHRQ CEDAR: Final Project Report 2022. (Prepared by Centers for Medicare & Medicaid Services Alliance to Modernize Healthcare (The Health FFRDC) under Contract No. 75FCMC18D0047.) AHRQ Publication No. 22-0064-1-EF. Rockville, MD: Agency for Healthcare Research and Quality. September 2022.

[3] The CEDAR Search client application itself was not the subject of the pilot, although at times pilot participants provided feedback on characteristics of the application as well. That feedback was provided to AAFP throughout the course of the pilot so that it could determine whether to update the application.

- **Pilot Partner Selection**: The project team established criteria to identify a successful pilot partner and a list of potential partners in collaboration with AHRQ leadership.
- **Planning and Development**: MITRE planned to operate the pilot with AAFP from February 2022 through July 2022. The partners developed a workplan to schedule and plan pilot activities. The MITRE CEDAR technical team collaborated with AAFP's development team to integrate the CEDAR API into AAFP's CEDAR Search application.
- **Pilot Testing**: AAFP recruited pilot participants for live user testing sessions ("think-aloud sessions") as well as asynchronous use of testing of the CEDAR API through CEDAR Search.
- **Data Analysis:** AAFP and MITRE gathered and analyzed qualitative and quantitative feedback from pilot participants (AAFP staff and members) and qualitative feedback from AAFP development staff.

Pilot Objectives

MITRE, in conjunction with AAFP and AHRQ, developed pilot objectives to ensure the pilot achieved both a test of the feasibility of integrating the CEDAR API into a third-party application and an evaluation of the demand among end users for the type of access to evidence that CEDAR offers. Data gathered was also applied to ongoing CEDAR API and CEDAR Search application development to ensure the API and prototype benefitted from real-time feedback on design and functionality. Pilot objectives and their descriptions are listed in **Table 1**.

Table 1. Pilot Objectives

Pilot Objective	Pilot Objective Description
Pilot Objective 1: Feasibility	Demonstrate the feasibility of integrating the CEDAR API into applications used in real-world research, clinical, and/or quality improvement settings.
Pilot Objective 2: Optimization	Discover successes, gaps, and improvements for existing processes, expectations, and/or tool integrations relevant to CEDAR.
Pilot Objective 3: Data-Driven Insights	Gather and leverage data-driven insights and lessons learned to inform future CEDAR development and pilots, and to make PCOR resources more FAIR.

Pilot Partner Selection

MITRE developed criteria for selecting a CEDAR pilot partner, assigning each criterion a relative priority level and minimum requirements for achievement. **Table 2** summarizes the high- and medium-priority selection criteria.

Table 2. High and Medium Priority Criteria for Potential Pilot Partners

Criterion	Priority	Minimum Requirements
Ability to effectively test CEDAR	High	End users with prior experience developing or using PCOR evidence
Ability to meet project timing and resource constraints	High	Willingness to commit to the project timeline and budget
Awareness of the CEPI repositories	Medium	Some existing familiarity with one or more of the CEPI repositories
Relevant technical knowledge and expertise	Medium	Basic experience with information management and search; ability to implement an API into existing infrastructure or new application
Enough relevant end users	Medium	At least 20 individuals who would be representative of real-world end users

MITRE sought a pilot partner able to recruit relevant end users, in addition to the technical readiness and expertise to integrate CEDAR into an existing or new application. MITRE considered several different organization types during initial pilot planning—including academic medical centers, care delivery organizations, health information technology or clinical decision support suppliers, medical specialty societies, quality improvement organizations, and research organizations—to assess their need for CEPI evidence and whether or not it was information potential pilot testers would be accustomed to using so that they could draw comparisons to researching the same information with CEDAR.

MITRE also developed several potential use cases to assist with identifying suitable pilot partners for CEDAR's first pilot. The use cases resulted in identifying several additional preferred pilot-partner characteristics, including the following:

- Focus on delivery or research in primary-care practice.
- Staff or affiliated individuals representing a variety of end-user types (e.g., clinicians or researchers with varied specialties and roles).
- Prior or existing connection to AHRQ and/or its evidence repositories.
- High level of engagement and/or interest in activities related to CEDAR.
- Ability to quickly enter into a pilot arrangement.

MITRE developed an initial set of potential pilot partners from discussions with AHRQ and other project connections. In fall 2021, MITRE presented a narrowed list of candidates and related use cases to AHRQ. After additional evaluation of how well each organization addressed the pilot-partner selection criteria and a review of any associated use cases, AHRQ approved a pilot with AAFP. With more than 130,000 members across 50 states and territories, AAFP was able to recruit end users of AHRQ evidence from diverse backgrounds in healthcare, including

guideline developers, practicing family physicians, medical educators, and researchers (collectively, "pilot participants"). AAFP also had the technical capacity in-house to develop an application into which the CEDAR API could be integrated and then tested by the pilot participants. Finally, AAFP staff and members actively use CEPI evidence and expressed familiarity with different repositories indexed in CEDAR. A pilot kickoff meeting was held on February 16, 2022.

Planning and Development

MITRE and AAFP determined the timeline, plans, and objectives for the pilot. The following tasks were identified and incorporated into the pilot work plan.

- **CEDAR Search development.** AAFP developed and iterated the application into which the CEDAR API would be integrated ("CEDAR Search"), followed by beta testing by MITRE and AAFP alike to refine CEDAR Search prior to going live in the pilot.
- **Evaluation planning.** MITRE and AAFP jointly developed the qualitative assessment questions for pilot participants, along with plans for virtual observation of participant application testing (think-aloud sessions). MITRE separately planned quantitative evaluations of usage data passively collected through API and the CEDAR Search application logs.
- **Pilot participant recruitment.** AAFP recruited, consented, and oriented nine researchers and/or guideline developers and nine actively practicing clinicians to test CEDAR Search.
- **Data collection and evaluation.** AAFP and MITRE collected qualitative and quantitative data. MITRE collected feedback from the AAFP developer on the experience of integrating the CEDAR API in CEDAR Search.

IRB Review

Because the pilot relied on participants to test the CEDAR API via CEDAR Search, MITRE and AAFP engaged their institutional review boards (IRBs) to ensure the pilot complied with requirements regarding human-subject protections.

The MITRE IRB determined that it could rely on the AAFP IRB to review the protocol and oversee the research; AAFP would conduct the bulk of the human-subjects related pilot activities, including participant recruitment and consent, scheduling, and data gathering and response deidentification. The MITRE IRB entered into an authorization agreement with the AAFP IRB, though it did also review the informed-consent form that AAFP planned to use.

On May 16, 2022, the AAFP IRB determined the project was exempt from human-subjects review and approved the submitted protocol. [4] On the same day, the AAFP IRB executed the authorization agreement, indicating that the AAFP IRB would function as the IRB of record.

Research Questions

MITRE identified 13 research questions to drive the data collection and analyses. These questions aligned to three domains representing outcome areas of people, process, and technology. The questions are also aligned with the specific pilot objectives described in **Table 1** (feasibility, data-driven insights, and optimization). The research questions are listed in **Appendix B**.

MITRE and AAFP arranged the gathering of qualitative and quantitative data from pilot participants and AAFP development staff. AAFP planned to collect pilot-participant observations from the responses to written assessments, communications between participants and AAFP staff, and conversations during think-aloud sessions. MITRE and AAFP also planned to gather quantitative data documenting search activity through activity logs and compare the results to equivalent searches for evidence in usual practice from the CEPI repositories. Once compiled, MITRE planned to map observations to topics, domains, and analysis questions to determine preliminary findings from this exploratory pilot.

CEDAR Search Development

AAFP developed and hosted the CEDAR Search application, allowing only pilot participants and the pilot teams to access the prototype through the use of a login and password. The CEDAR Search landing page provided introductory text describing the function and purpose of the platform, a list of the CEPI repositories searched, and a search-input field with instructions. When conducting a free-text search of CEDAR artifact titles and descriptions, users of CEDAR Search could enter a word, a phrase, or a logical combination of search terms [e.g., ((hypertension OR htn) AND afib)]. CEDAR Search submitted the user's terms to the CEDAR API, displaying its results in a human-readable form. Although the results showed the total number of matching artifacts at the top of the page, only the first 50 search results were retrieved and returned in the user interface. CEDAR Search incorporated filtering capabilities to restrict search results to an individual repository and resource type (e.g., guideline, recommendation, systematic review). The application also allowed users to send a search result to the email address they used to access CEDAR Search.

AAFP developed the first iteration of CEDAR Search in April 2022. AAFP staff and MITRE subject matter experts (SMEs) conducted beta testing in April and May. AAFP incorporated beta tester feedback on the functionality of the platform, content of the landing page information, and other identified user interface and user experience recommendations into CEDAR Search

[4] AAFP IRB Registration Number 00005133; Federalwide Assurance (FWA) Number 00 000 830.

throughout the beta testing period and finalized the CEDAR Search application for pilot participant use in late May 2022.

After the initial beta testing, a MITRE SME in organizational assessment and stakeholder interviews provided an educational session on effective user testing and think-aloud engagement to prepare the teams for testing CEDAR Search with pilot participants.

Participant Recruitment and Onboarding

To obtain representative data—particularly the CEDAR API's ability to facilitate evidence discovery—the pilot incorporated a range of participant backgrounds: researchers, clinicians, and developers.

After obtaining informed consent from each pilot participant,[5] the AAFP pilot team introduced them to CEDAR Search, providing documentation about the CEDAR API along with instructions on using CEDAR Search. Pilot participants reported any issues with CEDAR Search to AAFP, who then worked with MITRE to diagnose the cause, identify whether the issue was specific to CEDAR Search or the API, and address the concern. After conducting the onboarding task, the AAFP pilot team asked all participants (except developers) to interact with CEDAR Search at least three times within a period of approximately 8 weeks.

Data Collection and Management

MITRE and AAFP gathered technical information by tracking use metrics of the CEDAR API. AAFP further collected feedback from pilot users using two methods: deidentifying responses to written assessments and transcribing conversations in think-aloud sessions. MITRE gathered the qualitative data from assessments and transcribed conversations, uploading the results into a data management tracker for further analysis.

Pilot Testing

Activity Metrics

The CEDAR API automatically generated logs for specific user actions, including search queries or system errors.[6] MITRE collected two sources of data throughout the pilot test period to understand patterns of API use and to evaluate the performance of CEDAR.

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[5] Although the AAFP IRB determined that the pilot was human subjects research exempt, AAFP and MITRE opted to provide participants with informed consent anyway to ensure understanding of the pilot and how and what information would be collected.

[6] Pilot testers were informed that the CEDAR project collected their usage data (via logging mechanisms) as part of the pilot, and that no effort was or would be made to identify them via any information gathered.

- **Log data:** Specific data elements that are documented ("logged") each time the service is used for a search. These elements included query parameters and the total number of search results returned with each request.
- **User analytic data:** The number of clicks on individual CEDAR results, as well as the number of resources users emailed to themselves. These data also took the form of logs from the CEDAR API and AAFP's CEDAR Search, indicating a direct interaction with a search result.

The results, providing insight into pilot testers' preferences and experiences, were used to evaluate two aspects of CEDAR.

- Relevance and quality of search results
- CEDAR performance statistics

MITRE's evaluation of logged use metrics had some limitations. It lacked a meaningful way to compare participant performance using CEDAR against performance using the participant's previous research practices (e.g., time spent, resources used). The pilot also had no relevant baseline data against which to compare participant usage of CEDAR. MITRE proposed an approach that provided some of that comparison (e.g., conducting the same searches executed by pilot participants in the original repositories and documenting time spent). Because research is an individualized practice, however, the comparison could only be approximate.

Developer Assessment

The AAFP technical staff who created CEDAR Search completed a written assessment on the experience of integrating the CEDAR API into the CEDAR Search application. The assessment included 13 open-ended questions on the quality and comprehensiveness of CEDAR API's documentation, barriers encountered during development, previous experience with the standards used in CEDAR, the development time required to achieve project milestones, and the rationale for implementing specific API features.

Participant Think-Aloud Sessions and Assessments

AAFP conducted and facilitated six think-aloud sessions on the CEDAR Search application in online meetings. The AAFP facilitator limited the use of prompts and clarifying questions during the sessions to avoid biasing user behavior.

The think-aloud sessions had three goals:

- Understand the processes participants use in current practices or workflow without CEDAR.
- Observe how a participant uses CEDAR in real time to address a potential question or knowledge gap.
- Identify barriers to using CEDAR.

Up to three MITRE staff (including one development team member) attended think-aloud sessions to answer technical questions and take notes. To preserve participant confidentiality, MITRE staff were informed only of the participant's first name, and sessions used no video features other than those for screen share. MITRE staff compiled notes by hand, and that information was further reviewed for. In each session, the participant shared their computer screen to demonstrate how they would find information specific to their role (clinician or researcher), first by using their typical search methods (e.g., Google, UpToDate) and then by using CEDAR Search. The facilitator prompted participants to search for information located within CEPI's supported resources indexed by CEDAR. The facilitator encouraged participants to narrate their thought processes and verbalize feedback on the search experience and the quality of results.

During the recruitment period, pilot participants self-identified as either active clinicians or researchers. The pilot recruited nine of each end-user type (research or clinical).[7] All participants completed two written assessments: a "pre-use assessment" that was completed prior to testing CEDAR Search and a "post-use assessment" completed on average 4 weeks after having access to the CEDAR Search application. Because MITRE and AAFP sought different information from each user type, the assessment tools were distinct for each group. The assessments consisted of open-ended, free-response questions, along with others that employed Likert Scales to quantify the responses.

Data Analysis

At the completion of the pilot, the CEDAR team had collected:

- 18 pre-use assessment responses (9 clinician; 9 researcher).
- 18 post-use assessment responses (9 clinician; 9 researcher).
- Feedback from MITRE and AAFP development staff.
- 7 preliminary think-aloud session summary notes (beta testing prior to launch).
- 6 think-aloud session summary notes.
- 1,827 relevant log records across CEDAR API and CEDAR Search.

The CEDAR team developed evaluation matrices *a priori* to provide a framework for interpreting data collected during think-aloud sessions, as well as from pre- and post-use assessments. The CEDAR team also analyzed log information separately for quantitative summary and illustration of findings. This evaluation established preliminary findings on whether the CEDAR RI met pilot goals and larger project objectives.

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[7] Additional potential pilot participants were recruited for both categories of end user in the event a participant was lost to followup.

Quantitative Findings

Key findings from the different data collections and analyses are described here. Qualitative findings are organized by overall pilot objective: to test feasibility of implementation, to understand how to optimize the CEDAR API, and to obtain other insights about CEPI repositories.

Activity Metrics

Log data covered a period from May 25, 2022, to August 1, 2022, (the pilot period) and were sourced from both AAFP's CEDAR Search application and the CEDAR API. Data from CEDAR Search suggested 23 unique valid IP addresses, assumed to correspond to unique users who employed CEDAR Search on average 6.52 times each, with 150 total searches over the pilot period. The CEDAR team further used log data for three distinct types of analysis: to evaluate the relevance of search results, the quality of search results, and CEDAR performance. These are discussed in turn.

Relevance and Quality of Search Results

When pilot participants used CEDAR Search, the CEDAR API and CEDAR Search application created log record data automatically. MITRE used these log record data to understand how the pilot participants were interacting with CEDAR Search, including the time an individual spent using the application, how many returned results were clicked on, and how frequently participants emailed results to themselves. The evaluation of the relevance and quality of search results incorporated an assumption that participants' use of these features indicated they were finding relevant, quality search results that they wanted to review in more detail. **Figure 1** depicts the number of individual searches logged by the CEDAR API over time and the number of emails of specific search results that participants requested between May 25 through August 1 (the piloting period). Additionally, **Figure 1** displays the number of recorded clicks in which a participant opened the hyperlink presented in the result of a CEDAR Search query beginning July 7, which is when AAFP implemented this tracking capability.

Figure 1. Log Analysis: Searches, Clicks, and Emails Over Time

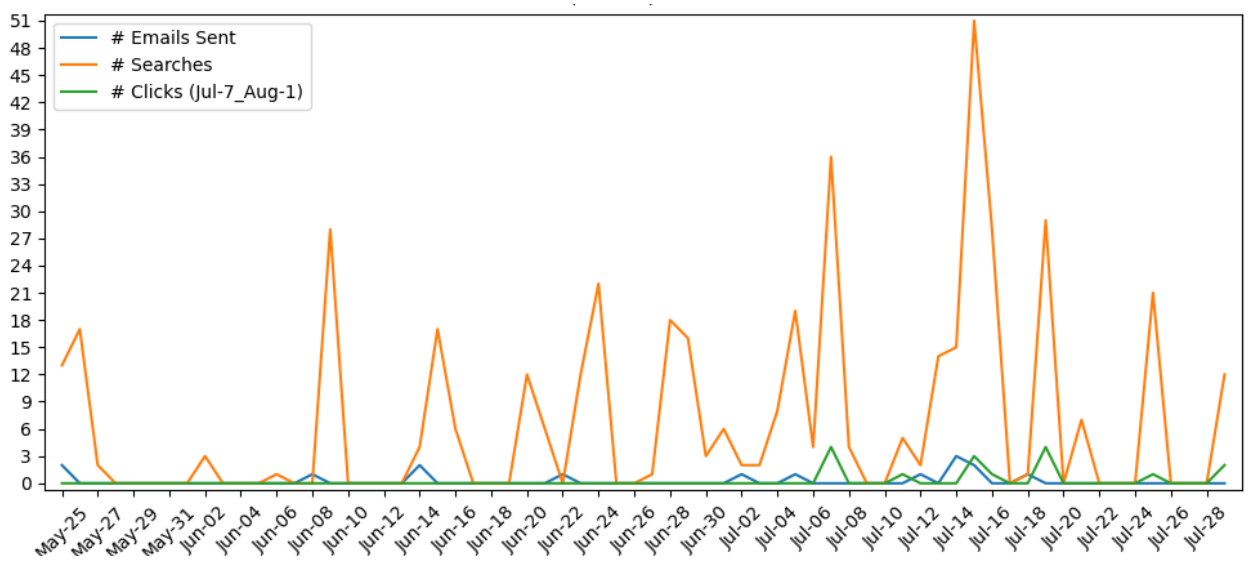


Figure 1 demonstrates pilot participant engagement, displaying a pattern between number of clicks or requested emails with the number of unique searches throughout the piloting period. The logs suggest a general increase in search volume over the pilot period, peaking in mid-July.

As previously mentioned, on July 7 AAFP added the capability to track how many CEDAR Search results a pilot participant clicked on when using the application. Over the next 22 days, 16 of the searches captured this information, representing approximately 11% of the total 150 searches sourced from the entire piloting period (May 25 through August 1, 2022).

In most searches, the user clicked on a result that was returned between the first and fifth hit.[8] This measurement of clicks by order of result display indicates that CEDAR Search presented relevant results that users were interested in further exploring. One finding from this set of comparisons is that further analysis may be needed to understand differences in the provided results to either confirm results provided by CEDAR are appropriately down selected for relevance or missing results it should be providing.

Performance Statistics Results

CEDAR incorporates results from individual CEPI repositories to offer FAIR access to evidence. In the absence of a previous baseline, MITRE evaluated approximate differences in performance between the CEDAR API and the repositories themselves. For this, MITRE sourced a list of 20 free-text search strings (benchmark terms) from CEDAR top searches and PubMed trending

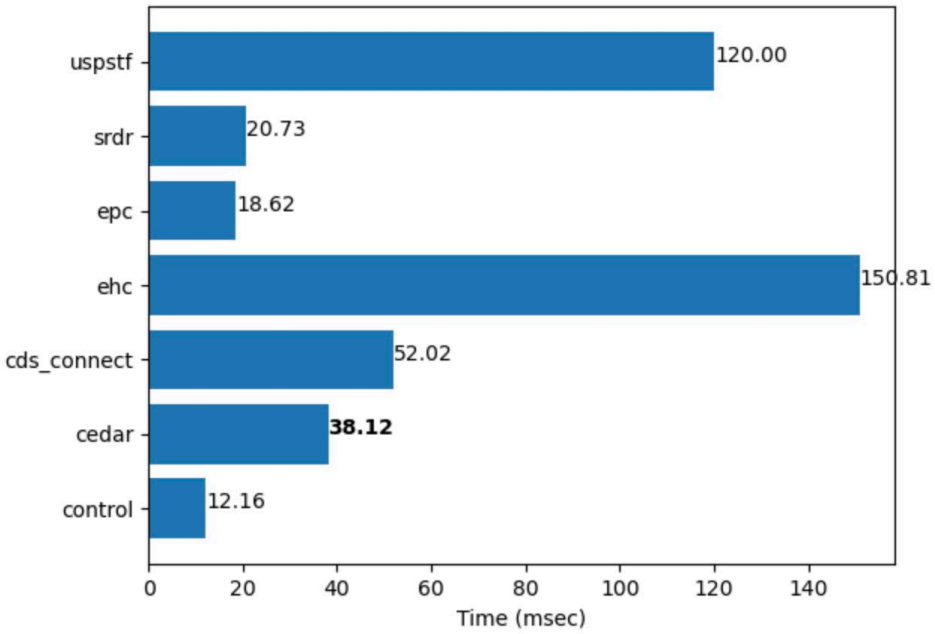
[8] Note: a search of "diabetes" had an usually high number of clicks on the sixth returned result, which is attributable to MITRE internal testing for functionality.

topics[9] and recorded times to receive results over five searches for each term, each source repository, the control (PubMed), and CEDAR. The same software that recorded these five measurements then dropped the minimum and maximum times to average the remaining three. These averages are compared here.

This software-backed methodology, while efficient, includes potential sources of measurement variance such as inherent network latency, performance of the system running the software, and any caching implemented by measured sources. While these sources of variance could impact each of the tested servers differently, they are unlikely to have enough impact to significantly impact the conclusions.

Figure 2 depicts the average time across the 20 benchmark terms to receive results, separated by repository. The analysis displays that CEDAR's performance metrics are comparable to, if not more efficient than, each repository it houses. However, CEDAR was also noted to be approximately three times slower than our control, PubMed, in search result return time.

Figure 2. Benchmarking Analysis: Average Search Time per Repository Across 20 Benchmark Terms



In the pilot assessments, many individuals stated that searching multiple sites is time consuming (see Appendix C). To add to this qualitative observation, MITRE staff explored the time it takes to return results from each of the five repositories should they be searched iteratively one at a time. **Figure 3** compares the findings from 20 sample search terms in milliseconds. Our analysis

[9] CEDAR Top Search Terms collected from CEDAR Admin (authentication required for access); PubMed trending page: https://pubmed.ncbi.nlm.nih.gov/trending/.

chose these specific 20 search terms to include the top 10 search terms queried during the CEDAR pilot, as well as the top 10 search terms queried in our control platform, PubMed. For further information on how long each individual repository housed within CEDAR takes to return results (summed together as 'All Sources' in the **Figure 3** legend), see **Table 3**. Of note, the times in **Figure 3** and **Table 3** present a foundation to represent how much additional time a user would spend to find results using multiple platforms compared to using CEDAR alone, keeping in mind this only quantifies the amount of time the platform takes to query results, and does not include the additional time expenditures associated with opening a browser, navigating to the website, entering the search terms, and initiating the search.

Figure 3. Benchmarking Analysis – CEDAR Versus All Sources Average Search Times

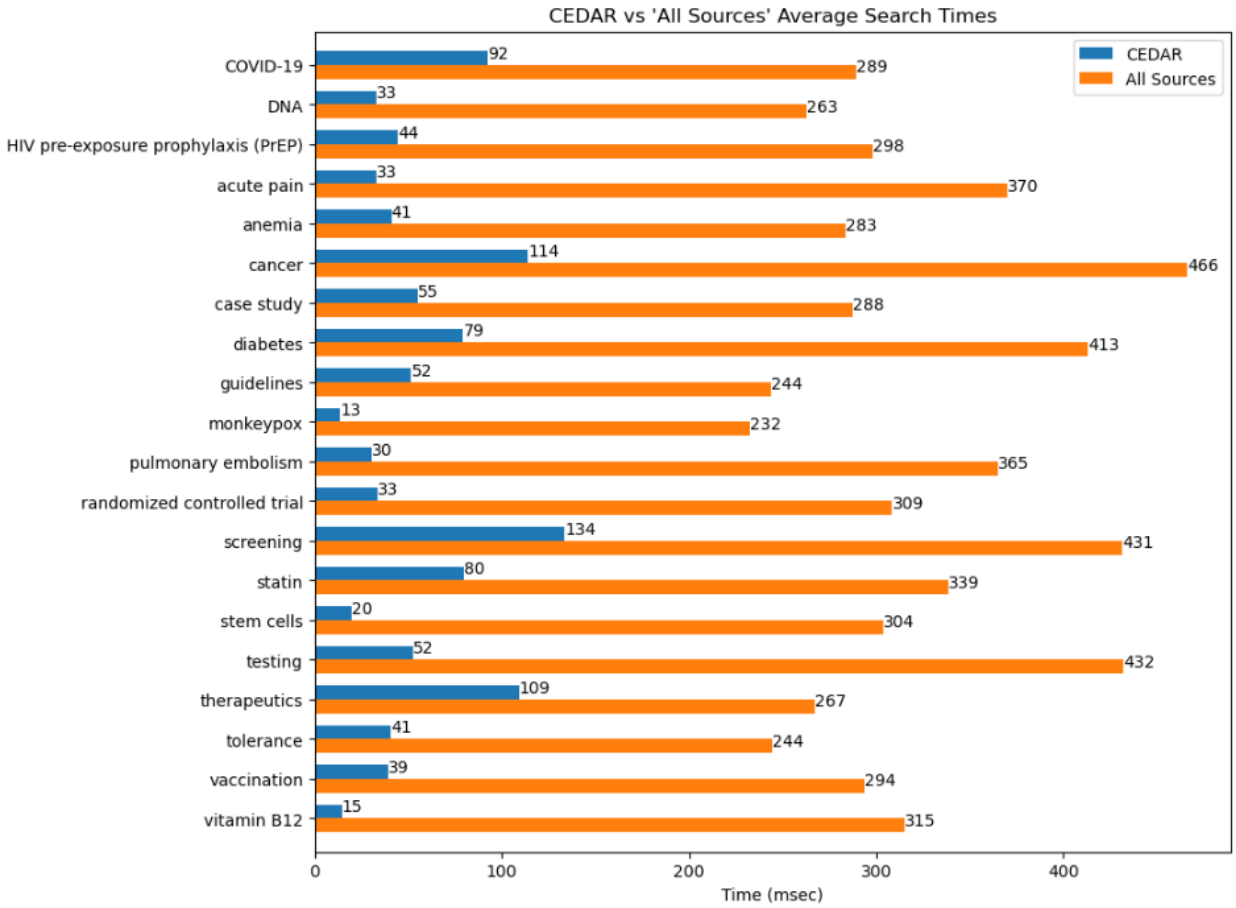


Table 3. Average Search Time (in Milliseconds) by Repository

Search Term	USPSTF	SRDR	EPC	EHC	CDS Connect
COVID-19	112.59	22.39	13.1	128.42	12.6
DNA	11.58	120.1	19.17	20.87	91.27
HIV pre-exposure prophylaxis (PrEP)	22.27	119.05	20.23	124.45	12.05

Search Term	USPSTF	SRDR	EPC	EHC	CDS Connect
acute pain	12.03	19.02	18.27	206.39	114.24
anemia	12.19	14.47	123.02	16.73	116.96
cancer	291.37	24.72	116.66	20.7	12.68
case study	11.17	139.91	17.84	21.27	97.39
diabetes	122.39	13.55	234.44	21.3	21.41
guidelines	20.22	85.87	11.95	13.43	112.21
monkeypox	112.35	15.47	12.56	75.04	17.06
pulmonary embolism	117.08	18.69	15.18	12.67	201.69
randomized controlled trial	114.97	137.92	17.91	11.75	26.02
screening	26.91	15.52	12.23	260.32	116.37
statin	115.95	11.76	174.51	14.73	21.59
stem cells	17.65	113.05	146	12.31	14.8
testing	25.77	24.73	123.31	246.21	12.12
therapeutics	11.97	106.13	21.36	113.61	13.85
tolerance	11.81	120.1	77.5	16.85	18.15
vaccination	12.51	119.29	20.51	102.73	38.77
vitamin B12	20.35	17.68	139.97	11.74	125.48

Table 4 displays the number of returned search results for the same 20 search terms in CEDAR compared to our control, PubMed. Again, these specific 20 search terms were chosen to include the top 10 search terms queried during the CEDAR pilot as well as the top 10 search terms queried in PubMed. As expected, PubMed returned a magnitude of larger search results.

For CDS Connect titles, CEDAR returns the same number of titles or more for every term, suggesting exclusive users of CDS Connect would benefit from CEDAR's larger breadth of sources.

For EHC titles, CEDAR returns fewer titles, except for "monkeypox," where both repositories return no results. This may suggest that CEDAR is more selective in what it incorporates from EHC or this may suggest that CEDAR's current EHC import algorithm is somehow lacking. The observation requires further analysis.

For EPC titles, the term "DNA" appears to be an outlier. When the CEDAR team observed the content of EPC results for DNA, it was not immediately clear that EPC results contained the term "DNA." The CEDAR team similarly observed "stem cells" results to compare and confirmed one of the two EPC results contained the term. It is unclear, currently, why DNA returns such a high number of results.

Similar to comparing with CDS Connect, CEDAR returned the same number of results or more for each search term within SRDR, suggesting that exclusive users of SRDR may benefit from incorporating CEDAR into their search practices.

For USPSTF titles, the repository returns the same number of titles for every term. When observing the content of these searches instead of the count, the CEDAR team observed that USPSTF's search always returned the same results but ranked them differently according to the search term. If, for example, there are only eight results in USPSTF's "COVID-19" search, USPSTF would return all 132 results, with the eight COVID-19 results displayed first, followed by other possibly related results to sum 132 total hits (e.g., information housed in USPSTF on infectious diseases, pandemics, vaccine, etc.). CEDAR, on the other hand, only returns results that are considered directly or possibly relevant to the search term; in this case of a search for "COVID-19," CEDAR returns 19 results, a sum that includes USPSTF's eight and an additional 11 from other source repositories.

Table 4. Number of Returned Search Results from CEDAR and PubMed Compared to Each Individual Repository

Search Term	CEDAR	PubMed	CDS Connect	EHC	EPC	SRDR	USPSTF
COVID-19	19	275417	1	142	1	4	132
DNA	12	1802857	0	69	814	5	132
HIV pre-exposure prophylaxis (PrEP)	8	5155	0	1662	8	1	132
acute pain	36	100606	0	608	46	6	132
anemia	29	245515	0	220	8	0	132
cancer	368	4652705	0	1505	129	21	132
case study	57	2350639	2	1888	4	51	132
diabetes	191	880965	10	1146	23	9	132
guidelines	276	524551	9	1808	1	13	132
monkeypox	0	1049	0	0	0	0	132
pulmonary embolism	8	62417	0	102	8	2	132
randomized controlled trial	85	761337	0	1947	2	50	132
screening	634	5649734	26	1569	162	40	132
statin	28	63701	5	148	4	1	132
stem cells	3	411794	1	144	2	0	132
testing	273	3142152	10	2395	29	30	132

Search Term	CEDAR	PubMed	CDS Connect	EHC	EPC	SRDR	USPSTF
therapeutics	753	7307204	0	944	0	3	132
tolerance	23	594199	1	535	1	2	132
vaccination	18	461412	2	225	0	1	132
vitamin B12	0	34919	0	30	10	0	132

Qualitative Findings

Qualitative findings are first summarized by type of qualitative information gathered (developer and participant) and then discussed in more detail by overall pilot objective: to test feasibility of implementation, to understand how to optimize the API, and to obtain other insights about CEPI repositories.

Developer Assessment

Of the 13 questions contained in the developer assessment, three focused on the quality and comprehensiveness of the CEDAR API's documentation. Prior to CEDAR Search's development, the MITRE team provided AAFP technical staff with the CEDAR API Getting Started Guide and the CEDAR API Specification page, a tool that allows users to visualize and interact with the CEDAR API without building a client application. In assessing the inclusiveness of these resources, AAFP technical staff described CEDAR API's documentation as "comprehensive." The staff highlighted CEDAR's API Specification page as being key, noting:

> *"Being able to do an actual search and see the resulting data probably played the biggest part in helping [to implement] the API."*

However, AAFP technical staff did encounter one barrier when referencing example code in the CEDAR documentation, which was cited as the "main frustration" during development; the developer noted:

> *"[The] lack of documentation around what Fast Healthcare Interoperability Resources (FHIR) NuGet*[10] *package to install to get the example code to work for .Net."*

As a result of this feedback, MITRE updated the example code to document dependencies, including the correct version of the FHIR library.

Six questions gathered information on the technical staff's previous experience using the standards in CEDAR API and the time spent to achieve specific project milestones. While AAFP technical staff did not have prior experience using some of the standards in CEDAR (specifically

[10] See, e.g., https://www.nuget.org/packages/Hl7.Fhir.R4/.

FHIR), their first successful manual request to the CEDAR API took less than 1 hour to complete. The estimated time to develop CEDAR Search's first iteration was between 15 and 20 hours, with an additional 1 to 2 hours spent on changes recommended after the AAFP and MITRE staff beta testing.

The remaining questions delved into the rationale for implementing specific API features and the value of CEDAR functionality to end user goals. Due to a change in the AAFP pilot project management staff during the development phase of CEDAR Search, CEDAR Search was "mostly created in a vacuum" and designed to align with general search engine functionality.

Participant Think-Aloud Sessions and Participant Assessments

The CEDAR team collected 18 pre-use assessment responses, 18 post-use assessment responses, and qualitative data from 6 think-aloud sessions, which resulted in approximately 746 total unique comments. The team next parsed the content of each comment into an observation, each of which was tagged with the corresponding analysis question and other general themes or topics (e.g., Quality, Quantity, Time). The coding of each response into observations and subsequent tagging was quality checked by another team member. Disagreements in interpretation between coders and quality reviewers were adjudicated by discussion between the team members. Narrative overviews of the think-aloud sessions and participant assessments (clinician and researcher) are available in Appendix C.

Feasibility

Feasibility-related findings demonstrate the degree to which the CEDAR API can be integrated into applications used in real-world research, clinical, and/or quality improvement settings.

Receptivity to Using CEDAR

Clinician and researcher participants alike were receptive to using CEDAR.

Seven out of nine clinical participants used CEDAR Search in a clinical setting, and five out of those seven found it helpful in that setting.[11] Some clinician participants expressed caution about using CEDAR with patients, as well as enabling patients to use CEDAR Search on their own, suggesting that the information may be too technical and does not address patient needs.[12]

When asked whether CEDAR Search had positively impacted their work, six research participants indicated it had positively impacted their work,[13] and eight expressed interest in using CEDAR Search in the future.[14] These findings indicate that it will be feasible to integrate

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[11] Participants 1004, 1006, 1008, 1018, and 1019.

[12] Participants 1004, 1006, 1009, and 1019.

[13] Participants 1001, 1002, 1007, 1014, 1020, and 1021.

[14] Participants 1001, 1002, 1003, 1007, 1012, 1014, 1017, and 1020.

the CEDAR API into either research or clinical settings in the future through a UI similar to CEDAR Search.

Understanding the API's Purpose

Clinician participants did not generally report barriers to using CEDAR Search, some using it both in[15] and out of the clinical setting.[16] Clinicians envisioned that CEDAR Search and other applications of the CEDAR API would be useful in a variety of ways, such as:

- Collecting updates on treatments and clinical management.[17]
- Planning for patient sessions.[18]
- Accessing accurate medical information, quality information, and research information. [19]
- Educating others accessing data and developing evidence.[20]
- Finding additional evidence-based platforms or websites.[21]

One clinician participant observed that CEDAR Search was geared toward people who want only AHRQ resources.[22]

A majority of researcher participants (five) did not report experiencing any barriers or challenges to using CEDAR Search.[23] Others reported difficulties in understanding the information that the different CEPI repositories offer, as well as their expectation that the information would be current (e.g., incorporating the latest information about the efficacy of the COVID-19 vaccines) or contain patient-oriented materials.[24] This suggests that users of CEDAR may need more information about what type of evidence they will receive when they conduct a search in CEDAR.

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15 Participants 1004, 1006, 1008, 1011, 1012, 1018, and 1019.

16 Participants 1006, 1008, and 1018.

17 Participants 1004 and 1018.

18 Participant 1008.

19 Participants 1008 and 1019.

20 Participant 1006.

21 Participant 1018.

22 Participant 1009.

23 Participants 1001, 1007, 1014, 1017, and 1021.

24 Participants 1001,1003, 1005, and 1020.

Training or Support Needed for Use

Clinicians and researchers alike were able to use CEDAR successfully in the pilot period, and some indicated the training provided was sufficient. Several participants indicated not needing the training document at all.[25]

Because some of the researcher participants expected to access additional or different types of search content,[26] they might have benefited from additional material explaining the different repositories indexed by CEDAR, along with the types of evidence they contain. For example, one researcher reflected:

> *"[I] expected a ton of options to read through, like if I were to use PubMed."*

Effort Needed to Integrate the API into Existing Systems

In this pilot, only one organization, AAFP, integrated CEDAR into an application; the developer responsible for that integration reported needing to invest only a low level of effort and resources to complete the associated tasks.

Optimization

Findings related to optimization support the discovery of successes, gaps, and improvements for existing processes, expectations, and/or tool integrations relevant to CEDAR.

Barriers to Understanding

In general, participants did not directly express that they experienced barriers to understanding how to use CEDAR. Some participants, however, received either unexpected results or fewer results than anticipated.[27] For clinician participants using CEDAR in a clinical setting, two found that it did not provide them with information fast enough in the moment;[28] another reported that it provided too much information when a summary of results would have sufficed.[29]

Facilitating Navigation or Use

Multiple participants indicated that additional orientation information on the website homepage would be helpful;[30] a possibly contrary perspective was that participants also appreciated streamlined search results.[31] All clinician participants reported becoming familiar with

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[25] Participants 1017 and 1021.

[26] Participants 1001, 1002, 1003, 1005, and 1014.

[27] Participants 1002, 1003, 1008, and 1020.

[28] Participants 1006 and 1008.

[29] Participant 1012.

[30] Participants 1002, 1003, 1005, 1006, 1008, 1009, 1014, 1017, and 1020.

[31] Participants 1008 and 1012.

previously unknown CEPI resources indexed by CEDAR through the course of the pilot.[32] On the other hand, only four of the nine researcher participants felt that the results provided enough information across a variety of CEPI resources.[33]

Research participants had multiple suggestions for the user interface of the pilot application itself.

Ease of API Implementation

While AAFP technical staff did not have prior experience using some of the standards in CEDAR (specifically FHIR), the documentation provided by the MITRE team was sufficient for implementation of the API into the AAFP's CEDAR Search application, and AAFP's first successful manual request to the CEDAR API took less than 1 hour to complete. Testing the API using Swagger was helpful in implementing CEDAR. AAFP technical staff did not have a specific set of requirements and were free to select any of CEDAR's existing functionalities to implement in the CEDAR Search application, so they implemented those functions they thought would be most useful based on their own experience using a search engine.

Data-Driven Insights

Findings related to data-driven insights can inform future CEDAR development and pilots; they can also be used to make PCOR resources more FAIR.

Addressing the Needs of Clinicians, Researchers, and Other Stakeholders

Three clinician participants used CEDAR in a clinical setting; two of these participants used CEDAR with a patient or in response to a patient question.[34] Six clinical participants reported that they would use CEDAR if made publicly available.[35]

Of the research participants, six indicated that using CEDAR positively impacted their work,[36] and eight expressed interest in using CEDAR Search in the future.[37] Researcher participants found benefit from CEDAR Search's aggregating information from different repositories (leading to time savings)[38] and highlighting high-quality, evidence-based resources.[39] All

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[32] Participants 1004, 1006, 1008, 1009, 1011, 1012, 1015, 1018, and 1019.

[33] Participants 1001, 1007, 1014, and 1021.

[34] Participants 1006 and 1011.

[35] Participants 1004, 1006, 1008, 1015, 1018, and 1019.

[36] Participants 1001, 1002, 1007, 1014, 1020, and 1021.

[37] Participants 1001, 1002, 1003, 1007, 1014, 1017, 1020, and 1021.

[38] Participants 1001, 1002, 1007, 1020, and 1021.

[39] Participants 1001 and 1020.

researcher participants also reported confidence in the search results, noting that the results came from trustworthy sources.[40]

Impact on User Workflow

Several participants expressed an interest in using a single location that could provide evidence-based resources from multiple different resources or repositories, noting that such a platform could save time and effort.[41] Many participants also observed that current methods of searching for evidence-based resources are time-consuming.[42] Most participants found that CEDAR addressed these concerns to a certain extent, though a few participants indicated that they hoped CEDAR would continue to grow and index additional resources.[43]

Overall, more than half the clinician participants reported that CEDAR increased the quality and quantity of search results alike.[44] That said, not all clinicians found it usable in the moment in the clinical setting.[45]

More than half of the researcher participants reported that CEDAR provided relevant results, and all but two reported that CEDAR increased the variety or quantity of results.[46]

Impact on User Insight Into the Scope of Available PCOR Resources

Prior to the pilot, not all clinician or researcher participants were familiar with or were users of each of the repositories or resources indexed by the CEDAR API, especially CDS Connect.[47] After the pilot, more than half of the clinician participants indicated learning about CDS Connect and SRDR through the use of CEDAR.[48] Several others also reported learning about EHC, EPC, and USPSTF.[49]

Most—but not all—researcher participants reported regularly using CEPI resources in their work before piloting the CEDAR Search application.[50] More than half of the researcher participants

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40 Participants 1001, 1002, 1003, 1005, 1007, 1012, 1014, 1017, and 1020.

41 Participants 1001, 1003, 1005, 1007, 1008, 1012, 1014, 1018, 1019, and 1021.

42 Participants 1003, 1006, 1007, 1009, 1011, 1018, and 1021.

43 Participants 1001, 1002, 1003, 1006, 1012, and 1020.

44 Participants 1004, 1008, 1012, 1015, 1018, and 1019 (increase in quality of relevant information); Participants 1004, 1006, 1011, 1012, 1015, 1018, and 1019 (increase in quantity of relevant information).

45 Participants 1011 and 1012.

46 Participants 1001, 1002, 1007, 1021, 1014, 1017, 1020.

47 Participants 1001, 1002, 1003, 1004, 1005, 1006, 1007, 1008, 1009, 1011, 1012, 1017, 1019, and 1021.

48 Participants 1008, 1009, 1011, 1012, 1019 (CDS Connect); Participants 1004, 1006, 1008, 1011, and 1012 (SRDR).

49 Participants 1004, 1008, 1015, 1018, and 1019.

50 Participants 1001, 1002, 1003, 1005, 1007, 1017, and 1021.

reported that their CEDAR Search results did not return sufficient information across a variety of AHRQ repositories.[51]

Barriers to Regular Usage of CEDAR

Clinician-identified barriers included the inability to obtain a search result that was helpful in the moment in clinic,[52] as well as results unsuitable for use during a patient visit.[53] Clinicians raised several shortcomings in applying the CEDAR Search application to patient use, including a lack of patient-level medical information, provision of guidelines without sufficient guidance or context, the inclusion of potentially outdated information, and the likelihood of making patient visits longer.[54]

Lessons Learned

MITRE and AAFP gathered lessons from two perspectives during the pilot: 1) those directly applicable to CEDAR from the findings of the pilot tests and engagement with the pilot participants and 2) those that can inform the planning and implementation of a future pilot.

CEDAR

- While the AAFP developer believed the CEDAR API documentation was sufficient, additional information on the FHIR Standard was useful for a developer who was unfamiliar with FHIR.
- The AAFP developer required a relatively low level of effort and resources to develop a successful CEDAR application.
- Pilot users unanimously reported that the CEDAR Search application was easy to understand. Users further elaborated that they needed very limited training and documentation to successfully navigate the platform.
- Evidence included in the CEPI repositories does not necessarily lend itself to use at the immediate point of care during a clinical encounter; instead, they may be useful for gathering information before or after the session. Reasons for this include the type of evidence artifacts AHRQ offers in the CEPI repositories and the pace with which the evidence is updated.
- End users of CEDAR (via either AAFP's CEDAR Search or a future application) often do not have familiarity with all the CEPI resources or the repositories that CEDAR indexes.

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[51] Participants 1002, 1003, 1005, 1017, and 1020.

[52] Participants 1006 and 1008.

[53] Participant 1012.

[54] Participants 1004, 1008, 1011, 1015, and 1019.

- Despite not being aware of some or all of the CEPI resources and repositories indexed by CEDAR, pilot participants reported trusting that the returned results came from reputable resources.
- Pilot users reported unexpected results, as well as results that did not address what the pilot participant was looking to find. Initiatives seeking to leverage CEDAR would benefit from ensuring a description of indexed repositories is easily found or available to end users.
- Using CEDAR increased participant knowledge of different CEPI repositories and resources. Advocating for expanded implementation of CEDAR may further the awareness and FAIRness of information maintained by CEPI.

Pilot Administration and Related Activities

- Requesting an hour of a subject's time to join a think-aloud session proved to be excessive and may have disincentivized their participation. Think-aloud sessions typically ran about 30 minutes; the hour requirement was more applicable to the organizers' time commitment. Participants may be more willing to participate in think-aloud sessions if they are booked for only 30 minutes, and the shorter session is unlikely to sacrifice its value.
- The IRB protocol application and review process created delay, even when one IRB agreed to defer to the other. Delays may not be avoidable; nevertheless, future CEDAR pilot applicants should submit their protocols as soon as possible to avoid potentially limiting the duration of pilot testing.
- When testing an API running on an application, care should be taken to distinguish between feedback relevant to the API versus feedback relevant to the features of the CEDAR Search application design.
- Future piloting efforts should identify and exclude activity from think-aloud sessions as well as internal functionality testing when compiling logging metrics to further quantify the use of pilot participants during the piloting period.

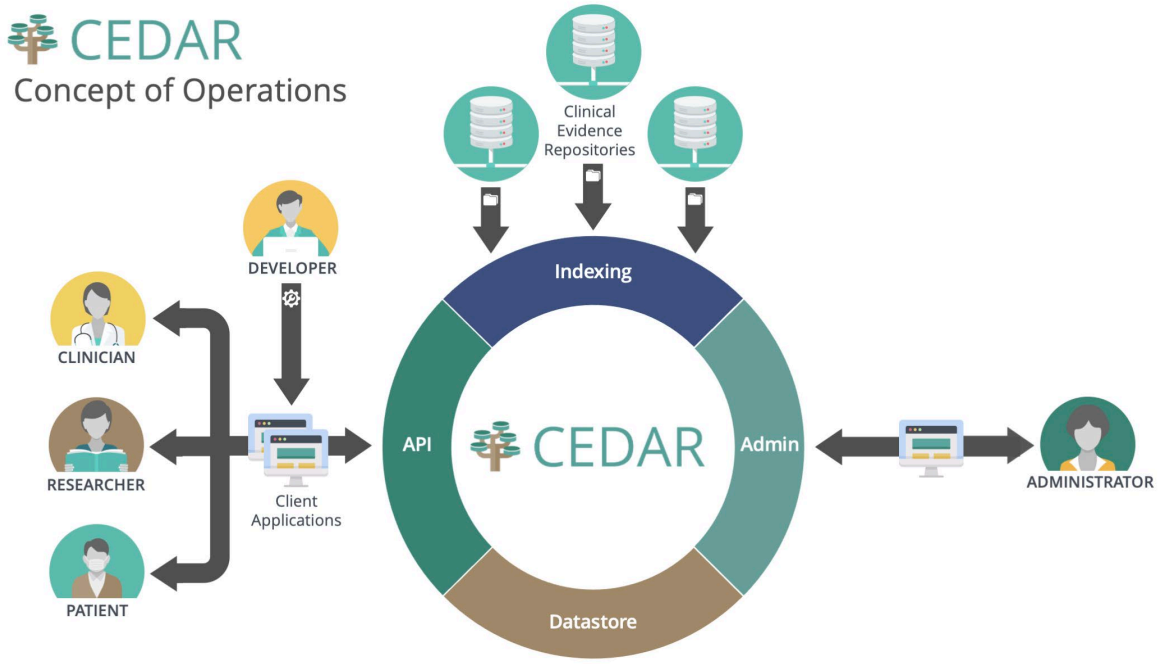
Recommendations

- AHRQ should devote additional resources for indexing data into CEDAR. While participants noted the benefits of the limited results and expressed interest in using a CEDAR application in the future, they also consistently shared a desire for more AHRQ content in its search results.
- CEDAR only indexes certain files from each of the CEPI repositories, which resulted in confusion when a participant could not locate a resource he or she knew existed. AHRQ could increase CEDAR content in the future by making CEDAR capable of locating additional files within each repository to index or by clarifying what information within each repository can be located using CEDAR. The latter would also enable developers seeking to use CEDAR to explain to their users what CEDAR indexes and the type of evidence that it offers.

- In future pilots or when developing demonstration user interfaces, the CEDAR team should partner with health science librarians and quality improvement researchers at academic medical centers to develop applications that would be useful and accessible to clinicians, researchers, students, and faculty alike.
- MITRE and any future API steward should provide guidance and recommendations to external developers for building a user interface that includes varying levels of CEDAR functionality, based on end-user needs. For example, a mobile interface might allow clinicians to use CEDAR in point-of-care settings or integration into the electronic health record (EHR) as a tool for planning patient encounters, communication, and followup. Developers may leverage insights derived from this pilot, including functionalities that pilot users frequently requested.
- Developers seeking to integrate the CEDAR API into an application may benefit from drawing on lessons learned when training anticipated end users about using CEDAR (e.g., reference information focused on searching, Boolean logic, and filtering to improve the relevancy of search results).

Appendix A. CEDAR Concept of Operations

Figure 4. CEDAR Concept of Operations



This Concept of Operations diagram illustrates the data flow as CEDAR indexes research data from various AHRQ resources (shown in the diagram as data flowing from Clinical Evidence Repositories to CEDAR) and provides tools for analyzing and administrating the indexed data. CEDAR makes all the data available via a FHIR-based API. The CEDAR FHIR API allows developers to directly integrate all the data CEDAR indexes from AHRQ into other applications, making the data available for clinicians, researchers, and patients. These users access and send queries to the API via Client Applications, searching the data indexed by CEDAR, and receive appropriate responses back.

The pilot engaged two types of stakeholders, who are represented on the left side of the ConOps diagram:

- Developers, who create client applications that use the CEDAR API to search for clinical evidence. In the pilot, AAFP developed the client application "CEDAR Search" and integrated CEDAR into that application to provide pilot testers the ability to search multiple CEPI repositories at once.

- Clinicians and researchers, who used CEDAR Search to search for clinical and research evidence pertinent to their interests. In the pilot, clinicians and researchers who were AAFP members tested CEDAR Search and provided feedback on their experience.

Appendix B. Research Questions Mapped to Objectives and Domains

Question Number	Domain (Who benefits?)	Objective (Why ask?)	Analysis Question
1	People	Feasibility	Are potential users receptive to using CEDAR?
2	People	Feasibility	Are potential users able to understand the purpose of CEDAR?
3	People	Data-driven insights	How does CEDAR address the needs of clinicians, researchers, or other stakeholders?
4	People	Data-driven insights	How does CEDAR impact a user's workflow?
5	People	Data-driven insights	How does CEDAR impact a user's insight into the scope of available PCOR resources?
6	Process	Feasibility	Do users require training or additional support to use CEDAR? If so, how much? What kind?
7	Process	Optimization	What might create barriers to understanding how to use CEDAR?
8	Process	Data-driven insights	What might create barriers to regular usage of CEDAR?
9	Process	Data-driven insights	What additional components need to be incorporated into CEDAR to increase the usefulness of results?
10	Process	Optimization	What additional components need to be incorporated into CEDAR to facilitate the navigation or use of the service?
11	Technology	Feasibility	How difficult is it for organizations to integrate CEDAR into existing systems or processes? What helped or hindered integration?
12	Technology	Optimization	What compatibility resource requirements (hardware, software, hosting, common data model, certificates, etc.) are needed to run or interact with CEDAR? Are these requirements feasible for clinical or academic organizations?
13	Technology	Optimization	How difficult is it for developers from an organization to integrate CEDAR into an application without assistance beyond provided documentation? What improvements to the documentation or other materials would be beneficial?

Appendix C. Narrative Overviews of Participant Think-Aloud and Assessments

Overview of Participant Think-Aloud Sessions

Think-aloud testing involved a 30–60-minute virtual session with pilot participants sharing their desktops and narrating the process of conducting searches in navigating the American Academy of Family Physicians' (AAFP) application of the Center for Evidence and Practice Improvement (CEPI) Evidence Discovery and Retrieval Project, which AAFP named 'CEDAR Search.' The participant was first asked to demonstrate how they would perform a search relevant to their research or clinical activities. The participant was next directed to open CEDAR Search, explore the platform, and perform a similar type of search. After becoming sufficiently familiar with CEDAR Search, the participant was asked to reflect upon the experience of using the reference implementation (RI). Six participants participated in a think-aloud session.

Much of the participants' observations focused on the user interface and functionalities of the CEDAR Search application, which were important for pilot partner development activities but less critical to the pilot test of the application programming interface (API) overall. Examples of these suggestions included clarifying filter capabilities, highlighting where the search terms appeared in the results, and adapting the language on the landing page.

In addition to identifying improvements specific to the CEDAR Search application, think-aloud sessions also identified several bugs in the API, which were addressed prior to granting the majority of pilot participants access to CEDAR Search. Examples of these bugs include search results that were unexpected or zero search results.

Participants observed that CEDAR has the potential to save time, with one participant stating that the more resources could be consolidated in one location the easier it would be for them to perform their research. One participant described the CEDAR Search application as a "short cut" to multiple resources in one interface. One participant wanted to have additional content returned in results. Participants also observed that CEDAR surfaces tools or resources they may not have thought to look for if conducting a search in their usual way. Another participant reported a wish that CEDAR return results that cannot be found elsewhere.

One participant recommended that CEDAR should be robustly marketed lest it be forgotten or overlooked. Another participant wanted it as a mobile phone app. One recommendation that was more specific to the user interface, but which may need to be incorporated into developer guidance, is to ensure the content being searched is described, so researchers know what kind of information they are pulling. Two participants thought that CEDAR could be helpful to their organization. Another thought it could be helpful for physicians studying for their board exams.

Overview of Clinician Participant Responses

Nine clinicians participated in the pilot of CEDAR Search. Of those nine clinicians, eight indicated they actively see patients in a primary care setting. Four reported additional specialties, including family medicine and sports medicine. Six indicated experience of 11-20 years treating patients; the rest indicated fewer years of experience.

All nine clinician participants indicated that they interact with EHRs or information technology (IT) resources multiple times each day. Clinician participants reported regularly using a variety of research resources, including the U.S. Preventative Services Task Force (USPSTF) and Centers for Disease Control and Prevention (CDC). Other sources frequently mentioned were UpToDate, PubMed, and Cochrane. Seven clinician participants reported they currently have the access to the information they need to effectively treat patients or otherwise conduct their work.

Clinician participants were asked to consider the ease and efficiency of the resources they currently use. Two participants mentioned the time it takes to find information, and one also noted that although some tools are available in EHRs, it is also necessary to seek information from a biomedical library. Seven participants agreed that having increased access to evidence-based research and recommendations would benefit patient care. Participants suggested increasing access by packaging information into a user-friendly manner that is easy to access and that accounts for clinician time constraints. One clinician participant also stated that being able to find information more easily would enable more efficient provision of patient care. In addition, two participants noted that more access to information means more opportunity to stay up to date on recommendations and provide higher quality of care.

Clinician participants reported it would be easier to find or use evidence-based information with simple user interfaces, rapid identification of sources, short and sweet responses, translation into different languages, more information in one place, linking information to the EHR, and education on different resources.

All nine clinician participants used CEDAR Search at least once or twice during the pilot period. One clinician participant reported using CEDAR Search very frequently (multiple times each week). The others reported usage of either 1-2 times each week (four participants) or 1-2 times total (four participants).

Seven used CEDAR Search in a clinical setting. Some clinical participants also used CEDAR Search in a nonclinical setting to conduct more general research and to teach. Searches from the clinicians who used CEDAR Search in a clinical setting included items such as patient care; answering clinical questions; and finding treatment guidelines, preventive care, and recommendations. One participant conducted a search with a patient.

Five out of the seven clinical participants who used CEDAR Search in a clinical setting found it helpful in that setting. One participant indicated that while it was helpful for one question, for another question the participant was unable to get a result that would help in the moment. Two clinician participants did not find it helpful in a clinical setting, with one participant explaining

that the search did not provide an easy summary of results. This feedback would need additional exploration to determine whether the dissatisfaction was with the way the CEDAR Search application was designed to present the results or if the information returned by the API was not sufficient or helpful.

Clinician participants were asked whether CEDAR Search increased the quality and quantity of evidence-based information:

- Six out of nine said CEDAR Search increased the quality of relevant information. Of these, five indicated "some" increase and one indicated "large" increase.
- Seven out of nine said CEDAR Search increased the quantity of relevant information. Of these, six indicated "some" increase and one indicated a "large" increase. One clinician participant reported a decrease in quantity of information returned.

Prior to the pilot, not all clinician participants were familiar with or were users of each of the repositories or resources indexed by the CEDAR API. During the pilot, several clinician participants reported becoming familiar with additional CEPI resources by using CEDAR Search:

- Five learned about CDS Connect.
- Two learned about EPC.
- Five learned about SRDR.
- One learned about EHC.
- Two learned about USPSTF.

Clinician participants believed clinicians could use CEDAR Search in several ways. They suggested clinicians would use it to get updates on treatments and clinical management; conduct pre-visit planning; access accurate medical, quality, and research information; and educate others on accessing data and developing evidence. Other clinician participants thought that there are already functional or comprehensive search instruments to access evidence-based research; CEDAR Search seemed geared to people who want AHRQ resources only.

Clinicians were asked about how CEDAR Search may be of benefit or use for patient visits or for patients specifically. Four clinician participants thought CEDAR Search could benefit patients, but only if it was tailored to give good, targeted information such as patient-centered guidelines. One indicated it would benefit patients by enabling clinicians to stay up to date.

Other clinician participants indicated CEDAR Search was too technical to benefit patients, but more exploration by the pilot team would be necessary to determine whether this is solely a user interface issue or a content issue. Another indicated that finding patient-level, accurate medical information is hard to do and wasn't clear that CEDAR would be able to fill that gap; similarly, another indicated that a search resulted only in risk factors, not guidance about care or best practices.

When asked about whether CEDAR could harm patients or the clinician-patient relationship:

- Four did not anticipate that CEDAR Search would be harmful. One participant conditioned this on the clinician and patient working together.
- Five thought it could be harmful, especially if patients do not understand what they are reading or if the information is outdated. One participant also indicated it could be harmful if patients look up guidelines and find their clinicians are not following them. Finally, one participant thought it could slow down a patient visit.

Overview of Researcher Participant Responses

Nine researchers participated. Researcher participants described performing a variety of research-related activities in their professional careers, including roles as scientific advisors, editors, guidelines panelists, and research collaborators. Three of the research respondents indicated they had 5-10 years of experience, four indicated 11-20 years of experience, and 2 reported having more than 21 years of experience in research. The types of research that researcher participants frequently engage in included literature reviews (seven participants), systematic reviews (five participants), clinical trials (five participants), and survey research (seven participants).

All nine researcher participants indicated that they interact with EHRs or IT resources multiple times a day. All researcher participants also indicated that they used multiple tools to conduct their research and reported using a wide range of resources and databases, including PubMed, EndNote, Cochrane, and clinicaltrials.gov. Researcher participants reported regularly using CEPI resources in their research: EHC (four participants), SRDR (two participants), and USPSTF (seven participants). Five also reported regularly using the National Guideline Clearinghouse before it was taken offline. Two participants reported not using any CEPI resources in their work, and no researcher participants reported using CDS connect or EPC in their research.

When researcher participants were asked, prior to using CEDAR Search, if they were able to efficiently find evidence-based information:

- Six responded "Yes," with prerequisites of ease of site navigation and help from a medical library. One participant noted it is time-consuming to search multiple repositories, and others observed that finding information was efficient within the systems as currently designed but not optimal for time savings.
- Three responded "No," and reported challenges that included resources in multiple locations, not always trustworthy, and behind paywalls, and searching multiple sites is time-consuming.

Researchers reported the following ideas of what would make it easier to find or use evidence-based information:

- Compile credible sources in one place (three participants) or, relatedly, creation of a search engine specializing in specific information (one participant).
- Greater full-text access (three participants).

In addition, one participant requested the re-release of NGC.

All research participants completed the post-use assessment and reported successfully using CEDAR Search at least once or twice during the pilot period to produce search results. Five participants reported using CEDAR Search 4-10 times, and three participants reported using CEDAR Search at least 3 times. Only one reported using CEDAR just 1-2 times.

Five researcher participants did not experience any barriers or challenges using CEDAR Search itself. Initial responses and barriers using CEDAR Search identified by other researcher participants included:

- Difficulty getting search results or search results that were relevant.
- Understanding the information that the different CEPI repositories offer. An example was that of CDS Connect, which a participant did not find helpful.
- Fewer results than expected; concurrently, one of these participants also observed too many results at times.
- Older results or results that were not all up to date. For example, a participant sought information on monkeypox and COVID-19 vaccine efficacy but was unable to do so.

Research participants selected their own search terms (search terms included "lung cancer screening," "COVID-19," "breast cancer screening guidelines," "implementation science," and "colonoscopy"). Asked whether the results they received were expected, three participants reported receiving the results they expected. Research participants reported expecting content that was more recent and more patient-oriented, greater volume of content and clinically actionable content, and tools in addition to USPSTF recommendations.

Research participants were asked to rate on a scale of 0 to 5 (with 0 meaning not relevant at all and 5 meaning highly relevant) the relevance of CEDAR Search results to their work. Six participants rated the relevancy of results at "4."

While some researcher participants felt that the results provided enough information across a variety of AHRQ resources, a majority (five) of the nine researcher participants reported that they did not receive enough information to fully satisfy their research needs. Participants requested that search results include results from other repositories besides USPSTF. Research participants also had multiple suggestions for the user interface of the CEDAR Search application itself, which were conveyed to AAFP.

Researcher participants were also asked whether CEDAR Search increased the variety or quantity of evidence-based results. While two participants reported that the results were limited by CEDAR Search, the other participants all reported increases between a little increase (three participants), moderate increase (two participants), and large increase (two participants).

Researcher participants described potential positive impacts of using CEDAR as time savings by compiling results from multiple repositories (five participants) and surfacing high-quality evidence-based resources, including those previously unknown (two participants).

Appendix D. Abbreviations and Acronyms

Term	Definition
AAFP	American Academy of Family Physicians
AHRQ	Agency for Healthcare Research and Quality
API	application programming interface
CDS	clinical decision support
CEDAR	CEPI Evidence Discovery And Retrieval project (AHRQ)
CEDAR UI	CEDAR User Interface
CEPI	Center for Evidence and Practice Improvement (AHRQ)
C-FAIR	CEDAR FAIR Tool
EHC	Effective Health Care Program
EHR	electronic health record
EPC	Evidence-based Practice Centers
FAIR	findable, accessible, interoperable, and reusable (guiding principles)
FFRDC	Federally Funded Research and Development Center
FHIR	Fast Healthcare Interoperability Resources
HL7	Health Level Seven (clinical standards and messaging formats)
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
IRB	Institutional Review Board
JSON	JavaScript Object Notation
MeSH	Medical Subject Heading

Term	Definition
NGC	National Guideline Clearinghouse
PCOR	patient-centered outcomes research
PDF	Portable Document Format (file type)
RDA	Research Data Alliance
REST	REpresentational State Transfer
RI	Reference Implementation
SME	subject matter expert
SNOMED	Systematized Nomenclature of Medicine
SNOMED CT	SNOMED Clinical Terms
SRDR	Systematic Review Data Repository
SRDR+	Systematic Review Data Repository Plus
UI	User Interface
UMLS	Unified Medical Language System (National Library of Medicine)
USPSTF	U.S. Preventive Services Task Force
VPAT	Voluntary Product Accessibility Template documentation
XML	Extensible Markup Language