Summary Report

Evaluation of the Agency for Healthcare Research and Quality Patient-Centered Outcomes Research Clinical Decision Support Initiative:

Findings and Recommendations for Future Initiatives

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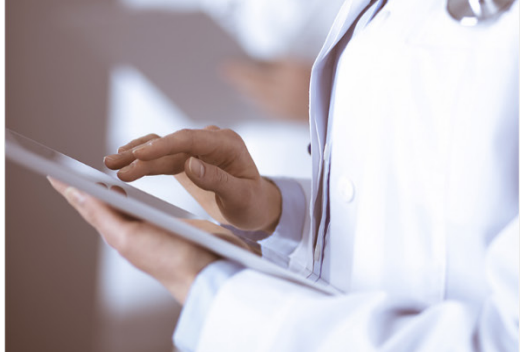


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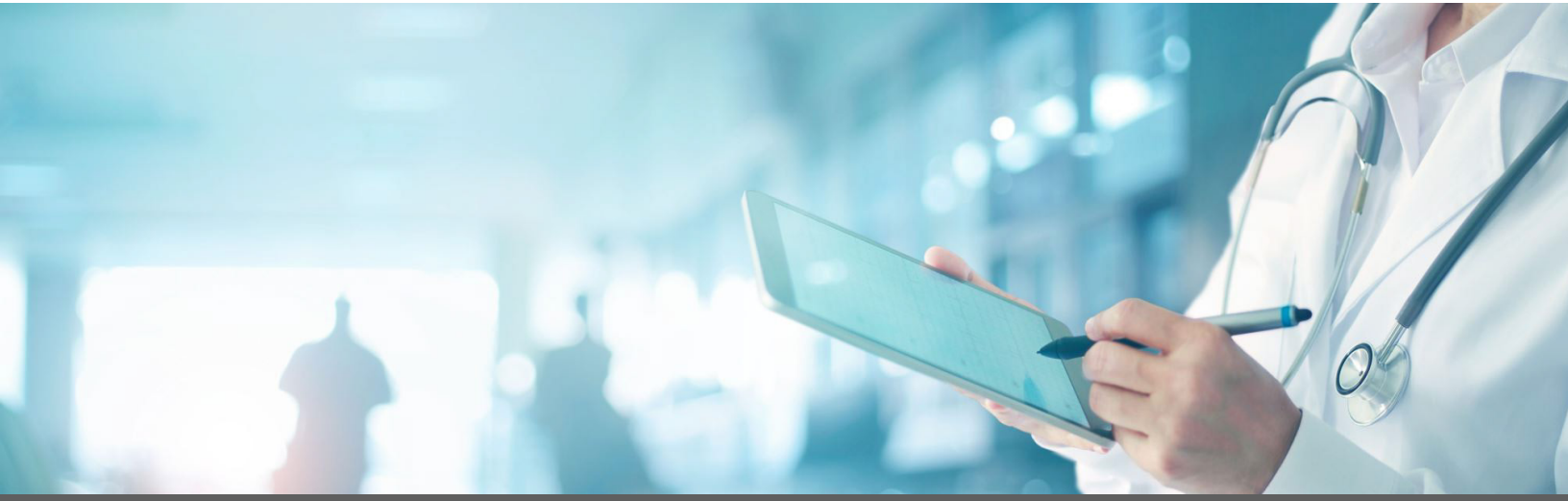
List of Exhibits

List of Acronyms

ACA	Affordable Care Act
ACG	Adapting Clinical Guidelines for the Digital Age
ACTS	AHRQ Evidence-Based Care Transformation Support
AHRQ	Agency for Healthcare Research and Quality
AMIA	American Medical Informatics Association
CDC	Centers for Disease Control and Prevention
CDS	Clinical Decision Support
CDSiC	Clinical Decision Support Innovation Collaborative
CEDAR	CEPI Evidence Discovery and Retrieval
CEPI	Center for Evidence and Practice Improvement
CMS	Centers for Medicare & Medicaid Services
CPG-on-FHIR	Clinical Practice Guidelines on FHIR
CQL	Clinical Quality Language
CVD	Cardiovascular Disease
EHR	Electronic Health Record
FHIR	Fast Healthcare Interoperability Resources
HIMSS	Healthcare Information and Management System Society
HL7	Health Level Seven
IT	Information Technology
KII	Key Informant Interview
MCBK	Mobilizing Computable Biomedical Knowledge
MITRE	MITRE Corporation
NIH	National Institutes of Health
NLM	National Library of Medicine
NORC	NORC at the University of Chicago
ONC	Office of the National Coordinator for Health Information Technology
PC	Patient-Centered
PCCDS LN	Patient-Centered CDS Learning Network
PCOR	Patient-Centered Outcomes Research
SMART	Substitutable Medical Applications, Reusable Technologies
TEP	Technical Expert Panel
USCDI	United States Core Data for Interoperability
USPSTF	U.S. Preventive Services Task Force



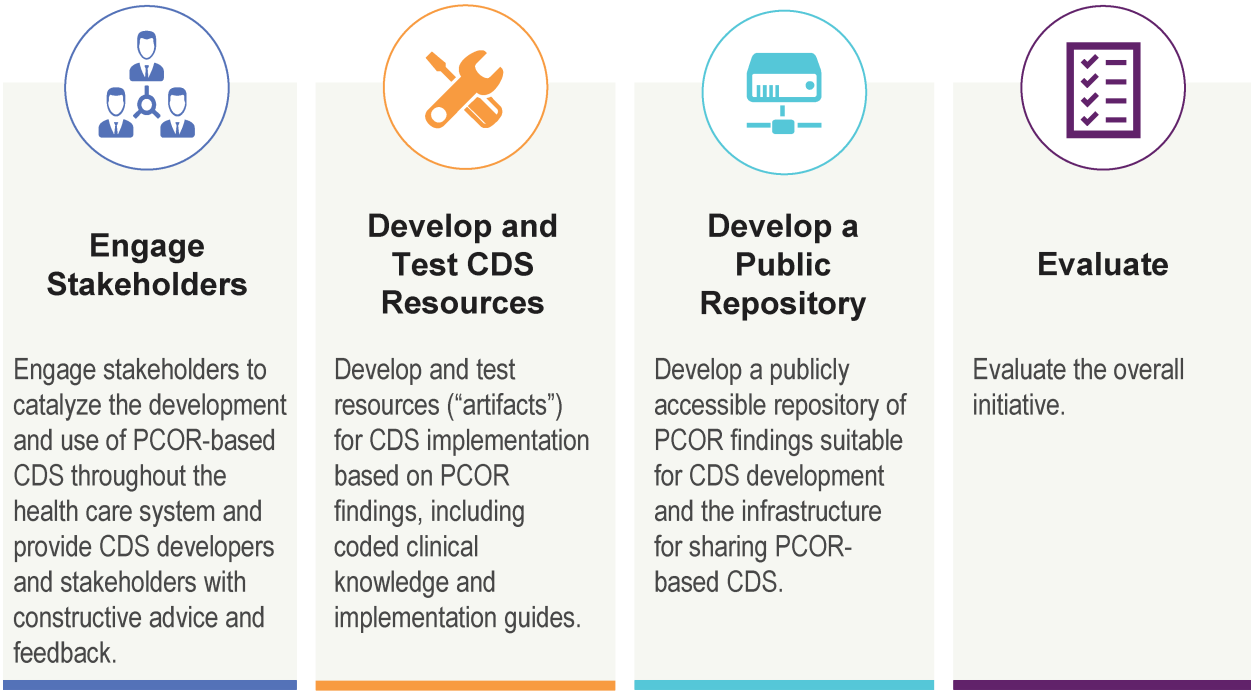
I. Introduction

This Summary Report encapsulates the findings from the evaluation of the Patient-Centered Outcomes Research (PCOR) Clinical Decision Support (CDS) Initiative (the Initiative). Funded by the Agency for Healthcare Research and Quality (AHRQ), NORC at the University of Chicago (NORC) conducted this evaluation from 2019–2022. In addition to describing the evaluation, the report provides findings and lessons learned about the Initiative's stakeholder engagement, product development, dissemination of PCOR evidence, development of standards-based CDS, and synergies with parallel CDS initiatives.

When fully implemented and used, CDS systems improve adherence to evidence-based practices, prevent medical errors, and support delivery of high-quality care.[1,2,3] Patient-centered CDS (PC CDS) "incorporates outcomes and measures that are meaningful to patients."[4] The degree to which CDS is patient centered depends on its knowledge base, data, delivery, and use in relation to patient needs and experience.

The Affordable Care Act (ACA) created new opportunities to support dissemination of PCOR findings through CDS.[5] The ACA mandates that AHRQ: 1) assist users of health information technology (IT) with timely integration of PCOR findings into clinical practice, through CDS that promotes ease of use; and 2) establish a process to receive feedback from physicians, healthcare providers, patients, CDS-focused health IT developers, appropriate professional associations, and public/private health plans regarding the value of the information disseminated and assistance provided. In response to this legislative mandate, AHRQ launched the multifaceted PCOR CDS Initiative in 2016 with two key goals: 1) advance evidence into practice through PCOR CDS; and 2) make CDS more shareable, standards-based, and publicly available. The Initiative sought to engage stakeholders, develop and test CDS resources, develop a public repository, and evaluate CDS implementation and outcomes (**Exhibit 1**).

Exhibit 1. AHRQ PCOR CDS Initiative Primary Activities



AHRQ PCOR CDS Initiative Components

The Initiative included five components:

- **The Patient-Centered CDS Learning Network (PCCDS LN):** Led by RTI International, the PCCDS LN engaged stakeholders through workgroups to 1) identify barriers and facilitators of PC CDS development and implementation, and 2) develop recommendations for implementing PCOR findings into CDS.[6]

- **CDS Connect:** Led by the MITRE Corporation (MITRE), CDS Connect provides an online platform that includes a repository of CDS artifacts (tools such as order sets, dashboards, and documentation templates), an Authoring Tool to create CDS, and prototype tools to aid in development and dissemination of evidence and standards-based CDS that is shareable and publicly available. MITRE also developed several CDS artifacts available in the Repository and maintains and updates these resources and tools.[7]

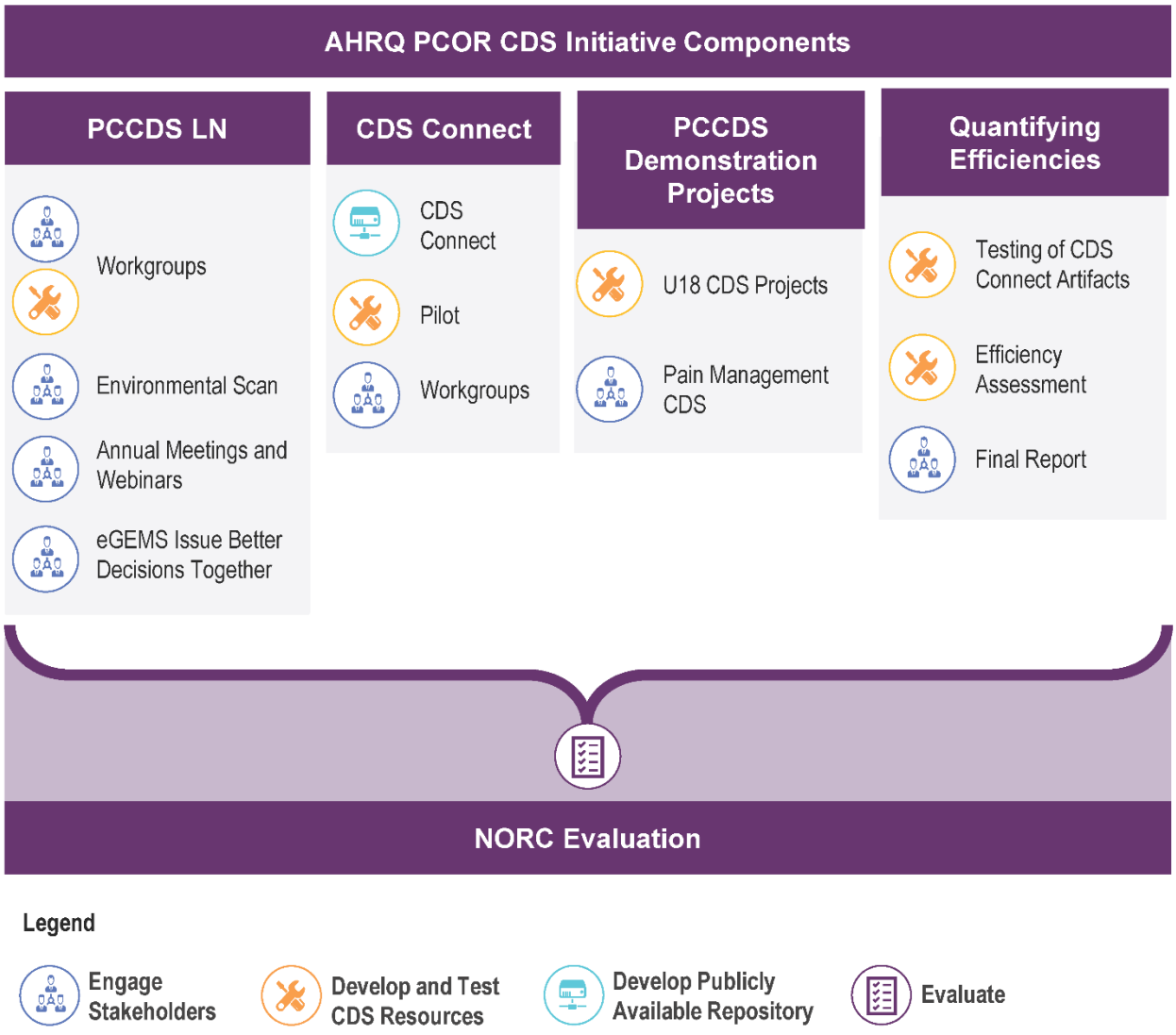
- **Quantifying Efficiencies Gained through Shareable CDS Resources (Quantifying Efficiencies):** Led by MedStar Health Research Institute (MedStar), Quantifying Efficiencies performed a usability assessment of CDS Connect resources. It also measured the impact of those resources on the efficiency of developing, implementing, and testing CDS among four different health systems, with comparisons within and across systems. A key task involved developing qualitative and quantitative metrics to

characterize the process and resources used during CDS design, development, and deployment.[8]

- **PC CDS Demonstration Projects:** Five demonstration projects, each under its own leadership, aimed to 1) develop, build, and evaluate shareable, interoperable CDS; and 2) make their products publicly available through CDS Connect. These projects included three cooperative agreements under the Advancing Evidence into Practice Through Shared, Interoperable Clinical Decision Support Resources (U18) grants, and two contracts focused on PC CDS for chronic pain management.[9,10]

The fifth and final Initiative component is NORC's rigorous mixed-methods evaluation of the four components to inform future CDS development, implementation, and dissemination efforts. **Exhibit 2** provides an overview of the four main program components' key activities.

Exhibit 2. AHRQ PCOR CDS Initiative Overview



II. Evaluation Goals and Research Questions

Two aims guided the evaluation: 1) assess the PCOR CDS Initiative's accomplishments; and 2) generate findings related to successes, challenges, and lessons learned to inform further AHRQ CDS program and policy initiatives. The evaluation does not examine changes in clinical outcomes that may have resulted from the implementation of products developed through the Initiative. The evaluation is also formative to the extent that findings related to Initiative processes and outcomes can be used to consider future AHRQ CDS program and policy initiatives that are broader in scope.

We addressed the evaluation goals by gathering qualitative and quantitative data to answer questions related to six domains of inquiry (**Exhibit 3**).

Exhibit 3. Research Questions by Domain

1	**CDS Ecosystem Stakeholder Engagement:** How were stakeholders engaged in the PCOR CDS Initiative, and what were their perceptions of their roles, representation, and the Initiative overall, including its place in CDS development nationally? What were lessons learned about engagement?
2	**Product Development:** What products helped AHRQ meet its legislative mandate (Section 6301 of the ACA) for dissemination/implementation of PCOR evidence as CDS, and what were the successes/challenges with these products?
3	**Dissemination:** To what extent did the Initiative promote the dissemination of PCOR findings through shareable, standards-based and publicly available CDS, and how?
4	**Development and Implementation of CDS:** To what extent did the Initiative promote the implementation of PCOR findings through shareable, standards-based and publicly available CDS, and how? What have participants learned about CDS development through the Initiative?
5	**Parallel Initiatives:** How did the Initiative relate to other collaborative CDS initiatives, and what could be learned from the current Initiatives that could be applied to future ones?
6	**Informant Lessons about Sustainability and Future Initiatives:** What lessons have Initiative participants generated about sustainability and potential future dissemination and implementation initiatives? How could these lessons inform future initiatives aimed at the dissemination and implementation of clinical evidence?

III. Methodological Approach

NORC collected and analyzed data from four sources: a literature review, a review of Initiative program materials, key informant interviews (KIIs), and a web-based survey of CDS Connect users and potential users.

Additionally, findings from our evaluation were virtually presented in March and July 2022 to a 22-member technical expert panel (TEP) for additional input on context and implications for the CDS field. Members included experts in CDS and informatics, health IT app development, and standards and measurement development, among other areas of expertise.

A. Literature Review

Across the 3-year evaluation, we conducted a targeted search of peer-reviewed and grey literature to gather insights into the Initiative components, as well as the broader development, implementation, and use of publicly available, standards-based CDS. In total, the team reviewed 687 published articles and 325 Google search items. We included peer-reviewed and grey literature referencing either Initiative components or a parallel collaborative CDS initiative. Publications that were excluded because they did not relate to the Initiative or a parallel initiative included clinical trials and studies (observational or qualitative) that focused on developing or testing non-CDS Connect artifacts. Initially, we identified 16 peer-reviewed publications and 32 grey literature reports related to the Initiative or a parallel initiative. An updated search the following year—using PubMed, Google, and Federal agency websites—yielded an additional 18 peer-reviewed publications and four grey literature reports relevant to AHRQ's PCOR CDS Initiative.

B. Program Materials Review

We collected 175 program materials that were publicly available from the four Initiative components. These included project reports, presentation slides, website descriptions, and meeting agendas and minutes. Four team members reviewed and summarized each document using an abstraction form. The team determined that 21 of the 175 documents required

additional analysis and used NVivo—a qualitative coding software—to thematically code each document. Two reviewers coded each program document independently to gather information about sustainability, trust, the CDS development process, and other key themes.

C. Key Informant Interviews

The team interviewed 41 key informants, including Initiative leaders (n=24); and contributors, participants, and consumers (n=17). The KIIs helped us understand the experience of Initiative participants, learn about the Initiative's components and potential impact, and discover reasons for participation and collaboration among stakeholders. Across the 3-year evaluation, three staff members coded the transcripts using NVivo to capture data related to the evaluation's research domains. One senior staff member reviewed quality across coders. Subsequently, the evaluation team analyzed the coded data to summarize findings related to the research questions and domains.

D. CDS Connect Usage Survey

The evaluation team developed a web-based survey—the CDS Connect survey—to understand why and how users used CDS Connect resources and perceived the resources' value. The survey, hosted on the Voxco Survey Platform, was launched on March 23, 2021, and concluded on June 7, 2021, resulting in 79 completed surveys out of a total sample of 713 individuals (an 11 percent response rate).

Limitations

The 3-year, mixed-methods evaluation has three limitations. First, the interviews and CDS Connect survey involved only Initiative leaders, contributors, and users. This focus prevented confident generalizations about the Initiative's broader reach. Second, our survey sample included individuals who signed up to use CDS Connect resources or had signed up to receive information via a listserv. Referrals to those outside the original survey sample were limited, which meant that respondents were somewhat familiar with CDS Connect or AHRQ's efforts. Additionally, there were a small number of respondents (79) and low response rate (11 percent). These factors combined have the potential to favorably bias estimates of the uptake of these resources. Third, we did not assess whether the underlying evidence base of CDS developed and disseminated under the Initiative was generated from PCOR or patient-centered research efforts relative to other types of research findings.

IV. Key Findings

We identified the following key findings for each evaluation domain.

A. CDS Ecosystem Stakeholder Engagement

Workgroups were an effective means of gathering input from diverse stakeholders on a common objective or product. The PCCDS Learning Network and CDS Connect components of the Initiative collectively: 1) convened nine virtual workgroups to gather stakeholder input on the conceptualization and development of activities and products; and 2) disseminated lessons and findings from those efforts through conferences, webinars, and publications. (See **Appendix A** for detail on the Initiative's stakeholder engagement activities.) The PCCDS Learning Network engaged the largest number of stakeholders and used the widest range of strategies. The CDS Connect Workgroup provided the most consistent and long-standing mechanism for engaging stakeholders, with monthly meetings from December 2016 through June 2022. The other components primarily engaged stakeholders as part of their CDS design and implementation activities.

The Initiative's components had robust engagement from some CDS ecosystem stakeholders (i.e., researchers, CDS developers), but not others (i.e., health systems, payers, health IT developers, and patients). Researchers, informaticians, and consultants who worked in the CDS development field were the most commonly engaged stakeholders across Initiative activities. Patients/patient advocates were challenging to recruit and engage in the Initiative's PC CDS development efforts, though all informants agreed that patient participation is critical throughout all phases of CDS development. CDS development project teams involved in the Initiative noted that engagement with the same patients throughout CDS design and development was particularly difficult—that it was more feasible to engage with different patients at different points in the iterative design process and to use the input of that group to move to the next phase with a new patient group. One patient advocate's consistent and vocal participation across several Initiative components was a notable exception. This patient advocate was instrumental in leveraging his patient advocacy network, social media presence, and podcast to recruit additional patient participants. Informants called for more resources on effective strategies for recruiting and engaging patients in CDS co-design efforts.

In discussing reasons for the low health IT developers' participation—despite the critical importance of getting their participation and input—informants noted that health IT developers

might be reluctant to share information due to concerns around sharing standards-based CDS development information that may be considered proprietary. Some informants noted that the few health IT developers who did participate were motivated by their desire to learn how to use Substitutable Medical Applications, Reusable Technologies (SMART) on Fast Healthcare Interoperability Resources (FHIR) technology in CDS development and implementation. The overall consensus was that AHRQ's funding of the Initiative's stakeholder engagement activities made AHRQ a leader in promoting standards-based CDS development.

B. Product Development

The Initiative's products galvanized attention to PC CDS by offering a definition for PC CDS, addressing the role of CDS in the growing field of patient-centered care, and developing frameworks and resources to support PC CDS development and advancement. The Initiative generated a wide variety of products—CDS development resources, white papers, CDS artifacts, and convenings—that helped AHRQ meet its legislative mandate for disseminating and implementing PCOR evidence as PC CDS.

By August 2022, the CDS Connect Artifact Repository included 74 artifacts, with contributions from the Veteran's Administration (VA), MITRE, Centers for Disease Control and Prevention (CDC), and other private or non-profit organizations.

The CDS Connect Artifact Repository successfully provided a platform to disseminate clinical evidence through standards-based CDS. The CDS Connect project built an Artifact Repository, developed an Authoring Tool for developing standards-based CDS, and pilot-tested several PC CDS artifacts. The majority of artifacts in the Repository (59 out of 74 as of August 2022) had a status of "draft" (rather than "active"), meaning they are under development and not ready for use as determined by the contributor (see **Appendix B** for detail). Of the private or non-profit contributors, the VA was the most frequent contributor to the artifacts available. Both CDS developers and researchers felt the Initiative produced valuable prototypes that pushed the field of standards-based CDS development forward.

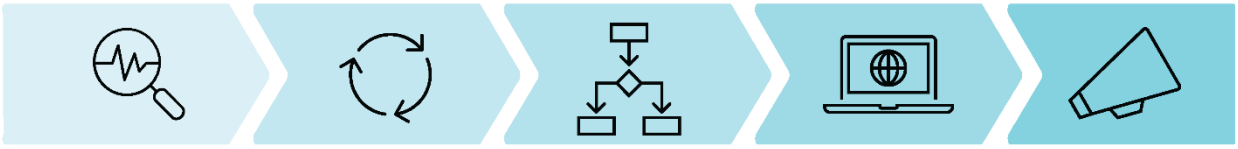
The five CDS demonstration projects produced PC CDS artifacts and written products illuminating emerging opportunities and challenges with developing PC CDS. The Initiative's demonstration projects also resulted in piloted artifacts to test functionality and/or assess clinician and patient user experiences. The artifacts were related to shared decision making, hypertension, adverse drug interactions, and chronic pain management (**Appendix C**).

C. Dissemination of PCOR Evidence through CDS and Initiative Products

The Initiative actively disseminated its products and findings through publications, conference and webinar presentations, blog posts, and uploads to GitHub, a freely accessible open-source software and code repository. We cataloged over 80 dissemination activities across the Initiative from 2016 through July 2022 (**Appendix D**). This included Better Decisions Together, a special collection dedicated to PC CDS research, in *eGEMS: the Journal of Electronic Health Data and Methods.*

Throughout the Initiative, CDS Connect served as a dissemination vehicle for federally funded CDS artifacts. AHRQ-funded demonstration projects that produced CDS artifacts were made available or will be available in the Artifact Repository. Some Federal partner stakeholders, including the VA and CDC, also used the Artifact Repository to fulfill mandates to make their CDS publicly available, confirming the Initiative's value across Federal agencies. In addition to being a dissemination vehicle for Initiative CDS artifacts, CDS Connect has been, and continues to be, a dissemination pathway for evidenced-based findings. The Initiative-developed artifacts used evidenced-based guidelines as their foundation, and these artifacts have the potential to reach clinical care teams, patients, and caregivers (**Exhibit 4**). However, we found limited evidence that CDS Connect artifacts have thus far been adapted and used within health systems. These artifacts currently require significant adaptations or further development before they can be readily installed and used within individual health systems.

Exhibit 4. CDS Connect as Dissemination Vehicle for CDS Evidence-Based Findings



Conduct comparative effectiveness and patient-centered outcomes research.	Synthesize findings from research through comparative effectiveness systematic reviews, clinical practice guidelines, clinical quality measures, and local best-practices.	Develop CDS artifacts leveraging evidence-based findings.	Use CDS Connect as a dissemination vehicle by publicly posting evidence-based CDS artifacts.	Disseminate CDS Connect through publications, presentations, webinars, and demonstrations.

D. Developing and Implementing Publicly Available, Standards-Based CDS

Implementing the growing body of standards and technology for publicly available, standards-based CDS remains challenging. Users' experience with the Initiative's CDS demonstration projects and CDS Connect pilots revealed that implementation of standards-based CDS is resource- and time-intensive, largely because electronic health record (EHR) developers did not support Clinical Quality Language (CQL) as a standard at the time of implementation. Significant effort was required to map standards-based CDS to EHR platforms' proprietary data elements. The varying standards EHR developers support also make it hard to predict the exact level of effort required for a specific CDS artifact implementation.[11] These challenges create continuing barriers to scaling CDS use across health systems using different EHR platforms and create particularly serious challenges for health systems lacking well-resourced and experienced IT units.

Trust and transparency are critical to the uptake of publicly available, standards-based CDS. We found that users and potential users of standards-based CDS artifacts made publicly available through CDS Connect are interested in easy-to-understand information about the underlying evidence base and the process by which the evidence was translated into CDS logic. Clinicians must be able to assess how the evidence-based guidelines are reflected in the CDS. CDS Connect has made several promising efforts to bolster trust in the Repository artifacts—including implementing a process for authors to review and update CDS artifacts with an "active" status (of which there are currently 10) and updating the CDS Connect Repository and other CDS Connect resources to ensure they adhere to the latest FHIR standards release and other applicable standards. However, further steps are needed. Informants suggested that a collaborative approach involving guideline developers in the development process and/or validation of the translation of evidence to computer code would bolster trust in the underlying evidence supporting publicly available CDS. CDS Connect artifact contributors similarly wanted more transparency, in the form of feedback loops with users, to understand how artifacts are used and any challenges or issues encountered that could be addressed in updates or iterative improvements. Available artifacts include the contact information of artifact authors, but no feedback mechanism is currently built into the CDS Connect Repository that can bolster users' trust.

E. Parallel Initiatives

AHRQ's PCOR CDS Initiative represents a uniquely valuable contribution to the CDS field. The evaluation identified four other projects that are similar or operating in parallel to AHRQ's Initiative (see **Appendix E** for detail):

- Centers for Disease Control and Prevention's Adapting Clinical Guidelines for the Digital Age (ACG)[12]
- HL7 Standards Development Initiatives[13]
- Mobilizing Computable Biomedical Knowledge (MCBK)[14]

- AHRQ evidence-based Care Transformation Support (ACTS) initiative (no longer active)[15]

These initiatives further galvanize the CDS ecosystem stakeholders toward developing shareable, standards-based CDS.

Despite some synergies between these initiatives and AHRQ's PCOR CDS Initiative, AHRQ's Initiative is distinct due to its explicit emphasis on 1) patient-centeredness; 2) development of publicly available, standards-based, and open-source resources; 3) focus on the entire lifecycle of CDS development; and 4) consistent funding of PC CDS demonstration projects.

The scope of the Initiative will also continue to expand with the establishment of the AHRQ Clinical Decision Support Innovation Collaborative (CDSiC),[16] which will also consider all stages of CDS development in its products, projects, and activities. The CDSiC aims to advance the design, development, dissemination, implementation, use, measurement, and evaluation of evidence-based, shareable PC CDS. The CDSiC also has an Innovation Center that focuses on conducting PC CDS research initiatives and projects in real-world applications related to CDS.[17]

V. Recommendations for Future CDS Initiatives

Throughout the evaluation, we gathered recommendations for future AHRQ CDS initiatives, primarily from key informants and a TEP, but also from program materials and the literature. These recommendations relate to stakeholder engagement and collaboration, resource development, research, dissemination, and sustainability.

A. Stakeholder Engagement and Collaboration

Regarding furthering stakeholder engagement, AHRQ should:

- **Encourage more guideline developers to collaborate in standards-based CDS artifact development.** Continued collaboration with the ACG initiative, in particular, presents a likely opportunity to better engage guideline developers.

- **Better engage EHR developers as partners in the adoption of standards-based CDS.** The CDSiC is already doing this as part of its Steering Committee and Workgroups. Other mechanisms for engaging EHR developers include participation in connectathons, encouraging developer participation in balloting efforts, and testing CDS interoperability in sandbox environments.

- **Collaborate with other leaders on promoting policy changes that engage health IT developers in standards development and CDS use/sharing**. Specifically, AHRQ could collaborate with the Office of the National Coordinator for Health Information Technology (ONC).

As AHRQ CDS Initiatives continue to grow and evolve, several additional, broader opportunities have emerged to engage with parallel initiatives. AHRQ could:

- **Collaborate with the ACG initiative as it engages partners and produces resources that the broader CDS community can leverage**. For example, together they could develop an evaluation framework for determining if the new FHIR standard for developing computable guidance has improved processes, products, and/or outcomes. Such a framework could inform work under CDSiC that is focused on characterizing the current state of the standards landscape.[18]

- **Engage the Health Level 7's (HL7's) Patient Empowerment Workgroup**. Though it was formed in 2019,[19] none of the survey respondents or informants indicated involvement in this workgroup, indicating a potential new opportunity to align AHRQ's Initiative with current patient-centered standards development work.

- **Identify synergies between MCBK and CDSiC workgroups**. Workgroups under both initiatives cover similar topics (e.g., trust and technical standards), and AHRQ could consider ways to engage MCBK community members to ensure they are aware of AHRQ Initiative activities.

B. Resource Development

Given AHRQ's pivotal role in the CDS ecosystem, it should continue to build trust in standards-based CDS by supporting the development of resources that:

- **Are open-source and provide greater transparency into the underlying evidence base and translation of that evidence into CDS.** Open-source CDS resources in and of themselves offer greater transparency than proprietary CDS, and transparency helps build trust in the underlying evidence base. Additionally, public reports about CDS pilots and CDS demonstration projects provide insight into key decisions made in the translation of evidence into standards-based CDS.

- **Provide implementation guidance of standards-based CDS in clinical settings.** Documentation to guide technical and clinical workflow integration of standards-based CDS tools builds confidence in using open-source tools. Examples of this type of implementation guidance can be found on CDS Connect.

- **Describe strategies for recruiting and engaging patients in CDS development**. In addition, strategies could describe lessons learned about engaging patients from AHRQ-funded CDS development projects.

- **Leverage Federal guidelines to develop standards-based CDS that most health systems will want to invest in adapting and maintaining.** For example, CDS Connect developed CDS artifacts based on U.S. Preventive Services Task Force guidelines. This helped avoid intellectual property restrictions, reduced the effort required to obtain appropriate permissions for making the resulting CDS publicly available, and enabled the development of a freely available product for primary care providers seeking to implement national preventive care guidelines in their practices. Using publicly available guidelines reduces the upfront investment in developing the CDS and has the potential to attract interest from large audiences of providers.

- **Provide more resources and case examples showing how CDS artifacts that fall short of "plug and play" can still be useful for health systems seeking to develop and implement standards-based CDS**. Such resources could help systems identify

next steps or offer examples for taking resources at a given level of readiness and advancing them to a higher level of readiness for implementation.[20]

C. Research

The evaluation identified two main areas for future AHRQ CDS research: standards development and measuring CDS Impact. Based on lessons learned from several AHRQ investments on development and implementation of standards-based and patient-centered CDS, AHRQ should consider.

- **Helping identify common data elements in CDS and having them incorporated into the U.S. Core Data for Interoperability (USCDI) and U.S. core FHIR profiles.** Having more standardized data elements in the USCDI will better enable CDS developers to draw upon them when building standards-based CDS.

- **Measuring CDS return on investment for health systems.** Informants emphasized that CDS sustainability fundamentally depends on its utility, value for clinicians and patients, and return on investment for health systems. According to TEP members, health systems will be motivated to use CDS if they can anticipate a return on the investment of time and resources required to adapt and implement the CDS. AHRQ should consider supporting pilot and/or demonstration projects on developing process and outcomes measures for CDS.

D. Dissemination

Increased awareness about Initiative products will encourage uptake and speed the progress of the CDS field toward generating, implementing, and using standards-based CDS. Based on informants' feedback, we recommend that AHRQ:

- **Explore additional ways to disseminate the Initiative's products that consider the specific ways different stakeholders use products.** These dissemination strategies could include conference presentations, innovation snapshots, blog posts, commentaries, editorials, press releases, issue briefs, videos, infographics, images, and/or tweetorials.

- **Support development of a standards-based national app marketplace or clearinghouse.** Such an effort could be similar to or an extension of the CDS Connect Repository.

E. Sustainability

Concerns about the sustainability of AHRQ-funded projects include the need to develop and use fully functional CDS beyond the funded demonstration period. In light of these concerns, AHRQ should:

- **Consider the lifespan of potential tools and resources developed under new funding efforts**. In a rapidly evolving field, AHRQ could encourage CDS developers to use the latest standards for tools and resources to endure past the project or contribute to the development of the field beyond specific projects.

- **Build requirements that sustainability be addressed in funded CDS grants and projects**. ARHQ may consider asking award recipients, as part of their funding requirements, to develop plans for the use of tools beyond a project period, either in their existing form, or as a building block for future projects.

Given the potential for publicly available, standards-based CDS to promote patient engagement and improve health equity, evaluation participants encouraged ongoing investments to sustain components, activities, and products, including through Federal and/or public-private partnerships.

VI. Conclusions

AHRQ created a robust PCOR CDS Initiative that tackled multiple aspects of advancing PCOR evidence into practice through the development and uptake of CDS resources. We found AHRQ to be an innovator in the standards-based CDS field and the Initiative to be pushing the field forward. However, our evaluation also found the field is not yet ready to use standards-based CDS resources developed under the Initiative. Finally, we found encouraging signs that many of the informant–derived recommendations offered above are already being implemented through ongoing AHRQ activities, including the AHRQ CDS Innovation Collaborative (CDSiC), the CEPI Evidence Discovery and Retrieval (CEDAR) Project, and the potential for a public-private partnership to sustain CDS Connect.

Appendix A: Summary of CDS Ecosystem Member Engagement Activities

Exhibit A1: Stakeholder Engagement Strategies

Initiative Component	Stakeholder Engagement Strategies
PCCDS Learning Network	**Workgroups**: Convened six workgroups, ranging from 14 to 102 members. Each worked with its own charge related to advancing PC CDS development. Workgroups worked together to produce outputs and recommendations for the field. **Annual Conferences**: Convened four annual conferences, ranging from 51 to 94 participants, three of which were opened to the public. Conferences included presentations, demonstrations, and opportunities to discuss PCCDS LN workgroup activities. **Webinars:** Held 12 webinars, averaging 92 attendees with a maximum of 175. Researchers and innovators from the field of PC CDS presented on specific CDS projects or current state of the field.
CDS Connect	**Workgroups:** Convened three workgroups over the CDS Connect contract, which met monthly. Two operated for only the first contract year (Cholesterol Management and CDS Repository Workgroups). The third, a more general CDS Connect Workgroup, continued until its final meeting in June 2022. **Patient Partnering Panel:** Convened in May 2021, the Partnering With Patients panel met four times over summer 2021. Invited panelists shared experiences integrating the patient/caregiver's voice in different phases of CDS development and implementation.
PC CDS Demonstration Projects	Development teams engaged with patients/patient advocates and clinician end users on the design of CDS tools and applications. Pilot testing and evaluation used qualitative discussions, and in some cases surveys, to gather feedback from patient and clinician testers.
Quantifying Efficiencies	Engaged a TEP to provide input on metrics to evaluate the CDS lifecycle stages and worked with four clinical sites to implement shareable CDS.

Appendix B: CDS Connect Repository Description

Updated based upon a review of the CDS Connect Repository as of August 14, 2022

Exhibit B2: CDS Connect Repository Artifacts

Artifact Description	N (%) (Total = 74 artifacts)
Top Contributors	
Veterans' Health Administration	32 (43.2)
The MITRE Corporation (CDS Connect project)	17 (2.0)
Centers for Disease Control and Prevention	8 (10.8)
Elimu Informatics, Inc	8 (10.8)
University of Pittsburgh Department of Biomedical Informatics	2 (2.7)
RTI-UNC Evidence-Based Practice Center	2 (2.7)
NORC at the University of Chicago/ Yale University	1 (1.4)
University of Pennsylvania Health System	1 (1.4)
Children's Hospital of Philadelphia	1 (1.4)
HLN Consulting, LLC	1 (1.4)
TISTA Science and Technology Corporation	1 (1.4)
Clinical Topic Areas	
Primary Care	15 (20.3)
Cardiovascular Disease	1 (1.4)
Diabetes Mellitus	7 (9.5)
Mental Health	9 (12.2)
Neurology	5 (6.8)
Neurosurgery	6 (8.1)
Substance Misuse Disorders	2 (2.7)
Other	29 (39.2)
Knowledge Levels (1-4)	
L1	0 (0.0)
L2	7 (9.5)
L3	64 (86.5)
L4	3 (4.1)
Artifact Type	
Event-Condition-Action (ECA) Rule	30 (40.5)
SMART Documentation Form	15 (20.3)
Order Set	10 (13.5)
Multimodal	9 (0.12)

Artifact Description	N (%) (Total = 74 artifacts)
Risk Assessment	4 (5.4)
Data Summary	3 (4.1)
Alert	1 (1.4)
Reference Information	1 (1.4)
Calculator	1 (1.4)
Users	
Patient-facing	12 (16.2)
Physician-facing	48 (64.9)
Both	1 (1.4)
Unspecified	13 (17.6)
Year of Publication	
2017	4 (5.4)
2018	21 (28.4)
2019	25 (33.8)
2020	7 (9.5)
2021	1 (1.4)
Unspecified	16 (21.6)
Average time between reviewing and publication	9.03 months*
Status of Artifact	
Draft	59 (79.7)
Active	10 (13.5)
Retired	4 (5.1)
Unknown	1(1.4)

* Some artifacts were missing the date of review.

Appendix C. Table of CDS Demonstration Projects

Exhibit C1: CDS Demonstration Projects

Project Name	Project Leader	Period of Performance	Partnering Organization/ Implementation Sites	Artifact Name(s)
CDS Connect Pilots				
Statin Use for the Primary Prevention of CVD artifact	MITRE	March - September 2017	AllianceChicago	Statin Use for the Primary Prevention of Cardiovascular Disease (CVD) in Adults: Clinician-Facing CDS Intervention
Pain Management Summary CDS	MITRE	March - August 2018	OCHIN	Factors to Consider When Managing Chronic Pain: A Pain Management Summary
Preventive Health CDS Interventions	MITRE	March - August 2019	b.well Connected Health	The pilot tested four artifacts: Behavioral Counseling to Promote a Healthful Diet and Physical Activity for CVD Prevention in Adults with Cardiovascular Risk Factors Abnormal Blood Glucose and Type 2 Diabetes Mellitus: Part One, Screening Abnormal Blood Glucose and Type 2 Diabetes Mellitus: Part Two, Counseling Statin Use for the Primary Prevention of CVD in Adults: Patient-Facing CDS Intervention: Patient-Facing CDS Intervention CMS's Million Hearts® Model Longitudinal ASCVD Risk Assessment Tool for Baseline 10-Year ASCVD Risk (which was within the Statin Use for Primary Prevention of CVD artifact logic)

Project Name	Project Leader	Period of Performance	Partnering Organization/ Implementation Sites	Artifact Name(s)
CDS Cooperative Agreement Projects (U18)				
Translating Hypertension Guidelines into Practice: Development of Interoperable CDS	David Dorr	September 2019 - September 2021	Oregon Health & Science University	Hypertension-related CDS
Enabling Shared-Decision-Making to Reduce Harm from Drug Interactions: An End-to-End Demonstration	Daniel C. Malone	September 2019 - September 2021	University of Utah	Drug-Drug Interaction CDS dashboard
Shareable, Interoperable Clinical Decision Support for Older Adults: Advancing Fall Assessment and Prevention Patient-Centered Outcomes Research Findings into Diverse Primary Care Practices (ASPIRE)	Patricia Dykes and Robert J. Lucero	August 2020 - July 2022	Brigham and Women's Hospital	Primary care fall prevention Patient-Centered CDS
CDS Demonstration Projects (Chronic Pain Management Projects)				
Shareable CDS for Chronic Pain Management to Promote Shared-Decision-Making (CDS4CPM)	Joshua Richardson and Laura Haak Marcia	September 2019 - September 2021	RTI International	MyPAIN for Chronic Pain (Patient-facing CDS) PainManager Dashboard (Clinician-facing CDS)
Tapering And Patient-Reported Outcomes for Chronic Pain Management (TAPR-CPM)	Kristen E. Miller and Aaron Zachary Hettinger	September 2019 - September 2021	MedStar Health Research Institute	Clinician-facing and Patient-facing CDS

Appendix D: PCOR CDS Initiative Dissemination Activities

Published Literature Related to the AHRQ PCOR CDS Initiative

1. Lomotan EA, Meadows G, Michaels M, Michel JJ, Miller K. To Share is Human! Advancing Evidence into Practice through a National Repository of Interoperable Clinical Decision Support. Appl Clin Inform. 2020;11(1):112-121. doi:10.1055/s-0040-1701253
2. Richardson JE, Middleton B, Platt JE, Blumenfeld BH. Building and maintaining trust in clinical decision support: Recommendations from the Patient-Centered CDS Learning Network. Learn Heal Syst. 2020;4(2):e10208. doi:10.1002/lrh2.10208
3. Michel J, Flores E, Mull N, et al. Translation of a C. difficile Treatment Clinical Pathway Into Machine-Readable Clinical Decision Support Artifacts Prototyped for Electronic Health Record Integration [Internet]. Rockville (MD): Agency for Healthcare Research and Quality (US); 2019 Nov. Available from: https://www.ncbi.nlm.nih.gov/books/NBK550362/
4. Ancker JS. Delivering Patient Data to Patients Themselves. EGEMS (Washington, DC). 2018;6(1):16. doi:10.5334/egems.267
5. Goehringer JM, Bonhag MA, Jones LK, et al. Generation and Implementation of a Patient-Centered and Patient-Facing Genomic Test Report in the EHR. EGEMS (Washington, DC). 2018;6(1):14. doi:10.5334/egems.256
6. Marcial LH, Richardson JE, Lasater B, et al. The Imperative for Patient-Centered Clinical Decision Support. EGEMS (Washington, DC). 2018;6(1):12. doi:10.5334/egems.259
7. Nystrom DT, Singh H, Baldwin J, Sittig DF, Giardina TD. Methods for Patient-Centered Interface Design of Test Result Display in Online Portals. EGEMs (Washington, DC). 2018;6(1):15. doi:10.5334/egems.255
8. Hochheiser H, Jing X, Garcia EA, Ayvaz S, Sahay R, Dumontier M, Banda JM, Beyan O, Brochhausen M, Draper E, Habiel S, Hassanzadeh O, Herrero-Zazo M, Hocum B, Horn J, LeBaron B, Malone DC, Nytrø Ø, Reese T, Romagnoli K, Schneider J, Zhang LY, Boyce RD. A Minimal Information Model for Potential Drug-Drug Interactions. Front Pharmacol. 2021 Mar 8; 11:608068. doi: 10.3389/fphar.2020.608068.
9. Michel JJ, Flores EJ, Dutcher L, Mull NK, Tsou AY. Translating an evidence-based clinical pathway into shareable CDS: developing a systematic process using publicly available tools. J Am Med Inform Assoc. 2021 Jan 15;28(1):52-61. doi: 10.1093/jamia/ocaa257.

Primary Dissemination Activities

Presentations

Initiative

- Blumenfeld B, deBronkart D, Lomotan E, McCready R. Accelerating Evidence into Practice: AHRQ's Clinical Decision Support Initiative. AMIA 2017 Annual Symposium; 2017 November 4-8; Washington, DC. American Medical Informatics Association
- Lomotan E. Accelerating evidence into practice: AHRQ's Patient-Centered Outcomes Research Clinical Decision Support Initiative. National Academies of Medicine. 2017 February 10; Washington, DC.

PCCDS LN

2016

- Richardson JE. The Patient Centered Outcomes Research Clinical Decision Support Learning Network (PCOR CDS-LN). AMIA 2016 Clinical Decision Support Workgroup; 2016 November 13; Chicago, IL. American Medical Informatics Association.
- Blumenfeld BH. The Patient Centered Outcomes Research Clinical Decision Support Learning Network (PCOR CDS-LN): transforming patient centered research into action. AMIA 2016 Ignite Series; 2016 November 14; Chicago, IL. American Medical Informatics Association.
- Middleton B. Patient centered outcomes research clinical decision support learning network (PCOR CDS-LN). HL7 Advisory Meeting; 2016 July 18; Ann Arbor, MI. Health Level Seven International.

2017

- Richardson JE. The analytic framework for action: a novel framework for organizing efforts in patient-centered clinical decision support. Academy Health IT Interest Group; 2017 June 24; Washington, DC. AcademyHealth.
- Blumenfeld BH. A learning network—improving the dissemination of PCOR-based clinical decision support. Academy of Managed Care Pharmacy (AMCP); 2017 January 21.
- Blumenfeld BH, Rutter JL, Siegel E, et al. Clinical decision support in the era of precision medicine. AMIA 2017 Annual Symposium; 2017 November 4-8; Washington, DC. American Medical Informatics Association
- Marcial LH. Development of a proposed analytical framework for action for PCOR-based CDS: strengths and weaknesses. AMIA iHealth 2017 Clinical Informatics Conference; 2017 May 2; Philadelphia, PA. American Medical Informatics Association.
- Callaham M. Analytic Framework for Action: A patient-centered outcomes research (PCOR) based clinical decision support (CDS) use case analysis. Health Datapalooza; 2017 April 27; Washington, DC. AcademyHealth.

- Richardson JE, Middleton B. Building nationwide capacity for PCOR-enabled CDS. 2017 HIMSS Annual Conference & Exhibition; 2017 February 20; Orlando, FL.

2018

- Richardson JE, Platt J, Blumenfeld BH, et al. Evaluating trust among multiple stakeholders for sharing knowledge in a clinical decision support ecosystem. 11th annual conference on the science of dissemination and implementation: scaling up effective health and healthcare: advancing the research agenda and necessary infrastructure; 2018 December 3-5; Washington, DC
- Blumenfeld BH. Promoting trust in shareable CDS artifacts. AMIA 2018 Annual Symposium; 2018 May 10; San Francisco, CA. American Medical Informatics Association.
- Blumenfeld BH. Clinical informatics efforts to combat the opioid crisis—Experiences from the frontline. AMIA Clinical Informatics Conference; 2018 May 10; Scottsdale, AZ.
- Richardson, et al. Draft Results: Promoting Trust in CDS Connect Artifacts. June 2018. CDS Connect Workgroup.
- Middleton, et al. Trust Framework Workgroup Final Whitepaper Overview: Promoting Trust in CDS Connect Artifacts. June 2018. CDS Connect Workgroup.
- Platt J, Richardson JE, Middleton B. Workshop: policy and coordination to ensure quality and trust incomputable biomedical knowledge. 2018.

2019

- Blumenfeld BH, Jerry Osheroff J. New strategies for using patient-centered technology to improve pain management and opioid treatment. Opioid Action Plan Psychiatry and Behavioral Health Learning Network; 2019.
- Marcial LH, Blumenfeld BH, Harle CA, et al. Barriers, Facilitators, and Potential Solutions to Advancing Interoperable Clinical Decision Support: Multi-Stakeholder Consensus Recommendations for the Opioid Use Case. AMIA 2019 Annual Symposium 2019 November 18; Washington, DC. American Medical Informatics Association.
- Richardson JE, Marcial LH, Middleton B, et al. Promoting trust, standards, and real-world applications for patient-centered clinical decision support. AMIA 2019 Annual Symposium 2019 November 18; Washington, DC. American Medical Informatics Association.
- Blumenfeld BH. Results from a multi-stakeholder action plan to better leverage patient centered clinical decision support in addressing the opioid misuse crisis. AMIA 2019 Annual Symposium; 2019 November 16-20, 2019; Washington, DC.
- Boxwala A, Desroche J, Middleton B, et al. Toward patient-facing clinical decision support: critical issues and near-term opportunities. AMIA 2019 Annual Symposium; 2019 November 20; Washington, DC.
- Blumenfeld BH. Addressing trust in clinical decision support knowledge artifacts. MCBK Trust and Policy Meeting; 2019 April 9.

- Blumenfeld BH. New strategies for using patient-centered technology to improve pain management and opioid treatment. NM Health Extension Regional Office Seminar: Best Practices for Treating Chronic Non-Cancer Pain in Primary Care; 2019 July 9, 2019.

2020

- Marcial LH, Lasater B, Richardson JE, et al. Enabling Patient-Centered and Interoperable Patient-facing Clinical Decision Support: Recommendations from the Learning Network. AMIA Clinical Informatics Conference; 2020 May; Seattle, WA.

CDS Connect

2017

- Lomotan E. CDS Connect: A New National Repository for Clinical Decision Support Knowledge Artifacts AMIA 2017 Annual Symposium; 2017 November 4-8; Washington, DC. American Medical Informatics Association.

2018

- Blumenfeld B, Middleton B, Sebastian S, Carney S, Michaels M. From Evidence to Action: Enabling Opioid Pain Management Guidelines Through Patient-Centered Clinical Decision Support. AMIA 2018 Annual Symposium; 2018 November 3-7; San Francisco, CA. American Medical Informatics Association.
- Lomotan E, McCready R, Sebastian S. CDS Connect Demo – CDS Repository and Authoring Tool. Adapting Clinical Guidelines for a Digital Age; February 5-9 2018; Washington DC.
- Moesel C. Pain Management Summary: A SMART on FHIR Dashboard for Managing Pain. AMIA 2018 Annual Symposium; 2018 November 3-7; San Francisco, CA. American Medical Informatics Association.
- CDS Connect System Demonstration. Mobilizing Computable Biomedical Knowledge (MCBK): 2nd Annual Meeting. 2019 July 18-19; Bethesda, MD.
- CDS Connect Presentation to Electronic Clinical Quality Measures Governance Committee. 2018.
- Lomotan E, McCready R. A National Repository of Widely-Shareable, Computable CDS. HIMSS18; 2018 March 5-9; Las Vegas, NV.

2019

- Al-Showk S, Moesel C, Sebastian S, et al. Authoring and Integrating Interoperable Clinical Decision Support: CDS Connect Open Source Tools. AMIA 2019 Annual Symposium; 2019 November 16-20, 2019; Washington, DC.
- Lomotan E, Michaels M, Michel J, Miller K. To Share is Human! CDS Connect: A Growing National Repository of Shareable, Interoperable Clinical Decision Support. AMIA Clinical Informatics Conference; 2019 April 30-May 2; Atlanta, GA. American Medical Informatics Association.

- Developing and Sharing Standards-Based Clinical Decision Support. Connected Health Conference. 2019 October; Boston, MA.
- Bundled Payments & Chronic Pain Management. HIMMSS Interoperability Showcase. 2019.
- Lomotan E, Al-Showk S, Bernstein S, Nix M, Sebastian S, Moesel C. Moving Closer to Interoperable Clinical Decision Support. HIMMSS Interoperability Showcase. 2019.
- Moesel C. Interoperable Consumer Decision Support: CDS Connect and b.well. AMIA 2019 Annual Symposium; 2019 November 16-20, 2019; Washington, DC.
- Meadows G. b.well Pilot Presentation. CDS Connect Workgroup. June 2019.
- Moesel C. Insights and Lessons Learned From CDS Connect Pilots. Insights and Lessons Learned From CDS Connect Pilots
- CDS Connect Presentation to U.S. Preventive Services Task Force (USPSTF) Health IT Forum. 2019.

2020

- Fabian L, Moesel C, Al-Showk, S, Gamache R, Lomotan E. CDS Connect – A Platform for Sharing & Authoring CDS Artifacts. Mobilizing Computable Biomedical Knowledge. 2020 June 30-July 1.
- Soares A, Richardson J, Solomonides A, Pan E, et al. The New Digital Age of Clinical Decision Support Tools: Open-Source and Interoperable Approaches for Health Systems. AMIA Virtual Annual Symposium. November 2020.

CDS Demonstration Projects

2020

- Gamache R, Richardson J, Miller K, Sargent W, White G, Kawamoto K, Federal Updates on Clinical Decision Support: Pain Management and Prescribing. Office of the National Coordinator for Health Information Technology Clinical Decision Support (CDS) Workshop. 2020 September 15.
- Marcial LH, Richardson J, Rizk S, et al. Development and Implementation of a Patient-Facing, FHIR-based Clinical Decision Support Tool to Support Shared Decision-Making for Chronic Pain. AMIA Virtual Annual Symposium. November 2020.

2021

- Gamache R, Marcial LH, Miller K, Richardson JE. Working Towards Shareable and Interoperable Patient and Clinician Facing Clinical Decision Support — Experiences from the Field. AMIA 2021 Clinical Informatics Conference. May 2021.
- Richardson J, Rhodes B, Rosenbloom ST, Cheng-Kai K, Marcial M. Perspectives on Developing and Implementing Shareable, Interoperable Clinical Decision Support for Chronic Pain: The CDS4CPM Project. AMIA 2021 Annual Symposium. November 1, 20201; San Diego, CA.
- Dorr D, Kawamoto K, Haque S, Gamache R, Marcial L. Stewardship Considerations in the Development and Implementation of Shareable SMART on FHIR Applications: Case

Studies on Multiple Chronic Condition Care Planning and Chronic Pain Management. AMIA 2021 Annual Symposium. November 2, 2021; San Diego, CA.

Quantifying Efficiencies

2019

- Al-Showk S, Lomotan E, Michel J, Miller K. Quantifying Efficiencies Gained Through Shareable Clinical Decision Support Resources. AMIA 2019 Annual Symposium; 2019 November 16-20, 2019; Washington, DC.

2020

- Miller K. Quantifying Efficiencies in Sharable CDS. CDS Connect Workgroup. March 2020.

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PCCDS LN

- Marcial LH, Richardson JE, Lasater B, Middleton B, Osheroff JA, Kawamoto K, Ancker JS, van Leeuwen D, Lomotan EA, Al-Showk S, Blumenfeld BH. The Imperative for Patient-Centered Clinical Decision Support. EGEMS (Wash DC). 2018 May 30;6(1):12.
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- Michel J, Flores E, Mull N, et al. Translation of a C. difficile Treatment Clinical Pathway Into Machine-Readable Clinical Decision Support Artifacts Prototyped for Electronic Health Record Integration [Internet]. Rockville (MD): Agency for Healthcare Research and Quality (US); 2019 Nov. Available from: https://www.ncbi.nlm.nih.gov/books/NBK550362/
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- Hochheiser H, Jing X, Garcia EA, Ayvaz S, Sahay R, Dumontier M, Banda JM, Beyan O, Brochhausen M, Draper E, Habiel S, Hassanzadeh O, Herrero-Zazo M, Hocum B, Horn J, LeBaron B, Malone DC, Nytrø Ø, Reese T, Romagnoli K, Schneider J, Zhang LY, Boyce RD. A Minimal Information Model for Potential Drug-Drug Interactions. Front Pharmacol. 2021 Mar 8;11:608068.
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- Salloum, R. G., Bilello, L., Bian, J., Diiulio, J., Paz, L. G., Gurka, M. J., Gutierrez, M., Hurley, R. W., Jones, R. E., Martinez-Wittinghan, F., Marcial, L., Masri, G., McDonnell, C., Militello, L. G., Modave, F., Nguyen, K., Rhodes, B., Siler, K., Willis, D., & Harle, C. A. (2022). Study protocol for a type III hybrid effectiveness-implementation trial to evaluate scaling interoperable clinical decision support for patient-centered chronic pain management in primary care. *Implementation science: IS*, *17*(1), 44. https://doi.org/10.1186/s13012-022-01217-4

Webinars

Initiative

- Lomotan E. Using Clinical Decision Support to Move Evidence into Practice: A Discussion with AHRQ. Association of American Medical Colleges. February 2019.

PCCDS LN (Includes webinars hosted by the PCCDS LN from outside presenters)

- Kawamoto K. PCOR Clinical Decision Support Interoperability Standards. PCCDS Learning Network Webinar. December 2016.
- Blumenfeld B. Introduction to the PCOR CDS-LN. PCCDS Learning Network Webinar. November 2016.
- Greenes B. The Transformation of our Health System - Disruptors and Implications for Clinical Decision Support. PCCDS Learning Network Webinar. January 2017.

- Richardson JE, Middleton B. Building Nationwide Capacity for Patient-Centered Outcomes Research-Enabled Clinical Decision Support. RTI International Brown Bag Series. February 2017.
- Van de Velde S. An International PCOR CDS Perspective: The Guideline Implementation with Decision Support Project. PCCDS Learning Network Webinar. February 2017.
- Williams M, Scherer J, McCready R. Patient-Centered Clinical Decision Support Learning Network Open Forum. PCCDS Learning Network Webinar. June 2017.
- Jellison J, Middleton B. Scaling Patient-Centered CDS for Disseminating Guidelines in Public Health: A Case Example. PCCDS Learning Network Webinar. September 2017.
- Wilder Smith A. Ask Once, Use Many: New Opportunities for Patient-Reported Outcomes in Healthcare Delivery. PCCDS Learning Network Webinar. November 2017
- Artz N, Myberburg S, Aponte A. CDS for Immunizations (CDSi): A Community and Standards-based Approach. January 2018.
- Platt J. Trust Frameworks: Policy and Legal Issues in Making Patient-Centered CDS Truly Shareable. PCCDS Learning Network Webinar. March 2018.

CDS Connect

- Sebastian S, Moesel C.A. National Web Conference on the Clinical Decision Support Authoring Tool. February 2019. https://digital.ahrq.gov/events/national-web-conference-clinical-decision-support-authoring-tool
- McCready R. CDS Connect: A Patient-Centered CDS Authoring Tool and Rules Library. PCCDS Learning Network Webinar. July 2017.

CDS Demonstration Projects

- Gamache R, Blumenfeld B, Miller K. Addressing Chronic Pain through Patient- and Clinician-facing CDS. PCCDS Learning Network Webinar. January 2020.

Blog Posts

PCCDS LN

- van Leeuwen D. About this Blogger. Patient-Centered CDS Learning Network Patient Experience Blog. 2018. https://pccds-ln.org/node/471
- van Leeuwen D. About this Blog. Patient-Centered CDS Learning Network Patient Experience Blog. 2018. https://pccds-ln.org/node/466
- van Leeuwen D. A Vision: Inching Toward the Ideal. Patient-Centered CDS Learning Network Patient Experience Blog. 2018. https://pccds-ln.org/node/456
- van Leeuwen D. A Vision: Clinician and Patient Perspectives. Patient-Centered CDS Learning Network Patient Experience Blog. 2018. https://pccds-ln.org/node/461
- van Leeuwen D. Innovating CMS Value-Based Measure Development. Patient-Centered CDS Learning Network Patient Experience Blog. 2018. https://pccds-ln.org/node/451

- van Leeuwen D. Measure Development: The Story. Patient-Centered CDS Learning Network Patient Experience Blog. 2018. https://pccds-ln.org/node/441
- van Leeuwen D. Measure Development: The Implementation. Patient-Centered CDS Learning Network Patient Experience Blog. 2018. https://pccds-ln.org/node/446
- van Leeuwen D. Decisions in a Bed of Trust, Part I. Patient-Centered CDS Learning Network Patient Experience Blog. 2018. https://pccds-ln.org/node/486
- van Leeuwen D. Decisions in a Bed of Trust, Part II. Patient-Centered CDS Learning Network Patient Experience Blog. 2018. https://pccds-ln.org/node/566
- van Leeuwen D. Decisions in a Bed of Trust, Part III. Patient-Centered CDS Learning Network Patient Experience Blog. 2018. https://pccds-ln.org/node/571
- Marcial L. Blog Status. Patient-Centered CDS Learning Network Patient Experience Blog. 2020. https://pccds-ln.org/node/876

CDS Connect

- van Leeuwen D. Putting Patients and Clinicians at the Center of CDS Development and Implementation. CDS Connect Patient Perspectives Blog. 2018. https://cds.ahrq.gov/cdsconnect/community/patient_perspective/november2018
- van Leeuwen D. Health Equity: A Key CDS Component. CDS Connect Patient Perspectives Blog. 2019. https://cds.ahrq.gov/cdsconnect/community/patient_perspective/april2019.
- Lomotan E. Enhancing the Use of Evidence with Interoperable Clinical Decision Support. Content last reviewed May 2019. Agency for Healthcare Research and Quality, Rockville, MD. https://www.ahrq.gov/news/blog/ahrqviews/enhancing-evidence-use-with-cds.html

PCCDS LN Annual Conferences

- Annual Meeting 2016: Conference and Strategic Planning Meeting. December 2016. Washington, DC.
- Annual Meeting 2017: Realizing the Potential of Patient-Centered Clinical Decision Support. October 2017. Crystal City, VA.
- Annual Meeting 2018: Leveraging Patient-Centered Clinical Decision Support: Addressing the National Opioid Crisis and Beyond. October 2018. Crystal City, VA.
- Annual Meeting 2019: Optimizing Health Through Patient-Facing Clinical Decision Support. October 2019. Washington, DC.

Appendix E: Parallel Initiatives

This table summarizes parallel initiatives described in interviews and CDS Connect survey.

Exhibit E1: Parallel Initiatives

Category	Initiatives Described In Interviews	CDS Connect Survey
Standards Development Efforts	• Evidence-Based Medicine on FHIR (EBM on FHIR) • Clinical Practice Guidelines on FHIR (CPG-on-FHIR) • SMART on FHIR • CQL Development Efforts	• EBM on FHIR -- HL7/ COVID-19 Knowledge Accelerator (COKA) • CPG-on-FHIR • SMART on FHIR • CQL Development Efforts • Computable Guidelines - HL7/IHE Gemini Project
Standards Adoption and Implementation/ Interoperability Efforts	• CDS Hooks Workgroup • CMS Promoting Interoperability Program • ONC EHR Certification • CDC Making EHR Data More Available for Research and Public Health (MedMorph) • NIH FHIR Working Group • CDC National Test Collaborative • AHRQ eCare Plan for Multiple Chronic Conditions Technical Expert Panel	• CDS Hooks workgroup - FHIR/HL7 • SMART Guidelines - WHO
Efforts to Support the Generation and Dissemination of Evidence	• AHRQ evidence-based Care Transformation Support (ACTS) Initiative • AHRQ Evidence-Based Practice Centers • Mobilizing Computable Biomedical Knowledge (MCBK) • Adapting Clinical Guidelines for the Digital Age • Patient Centered Outcomes Research programs and projects • AHRQ CEPI Evidence Discovery and Retrieval (CEDAR) Project	• AHRQ evidence-based Care Transformation Support (ACTS) Initiative • AHRQ Evidence-Based Practice Centers • Mobilizing Computable Biomedical Knowledge (MCBK) • Adapting Clinical Guidelines for the Digital Age
CDS Research, Development and Implementation Efforts	• VA Clinical Decision Support Knowledge Artifact (CDS KNART) Program • NIH-funded CDS Research Projects • Proprietary/Vendor sponsored workgroups • Open CDS	• Vendor-sponsored workgroups • Arden Syntax projects • OpenCDS • Pediatric CDS Collaborative (CHOA, Wake Forest, CHOP, Cincinnati Children's, Nationwide Children's, and Univ. of Rochester Medical Center) • Private efforts at Academic Institutions/Medical Centers/Health Systems • Proprietary/Vendor sponsored workgroups • National Academies of Medicine (NAM) CDS Initiative

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